

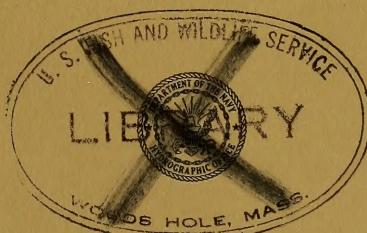
TECHNICAL REPORT

INVESTIGATIONS OF DEEP-SEA SEDIMENT CORES

II. MASS PHYSICAL PROPERTIES

ADRIAN F. RICHARDS

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A B S T R A C T

Thirty-five gravity- and piston-type cores were collected by the Hydrographic Office in depths of 400 to 5120 m from 8 different areas in the North Atlantic, Central Pacific, and West Mediterranean Sea. Most cores were composed of terrigenous silt- and clay-size particles. Mass physical property laboratory measurements of more than 700 samples included: grain size, specific gravity of solids, wet unit weight, water content, void ratio, pore-water saturation, liquid and plastic limits, and compressive and/or vane shear strength. Also computed were porosity, liquidity index, plastic index, cohesion, sensitivity, activity, and modulus of elasticity.

Depth in cores generally was found to be directly related to wet unit weight and cohesion, inversely related to measures of water content, and a variable relation to median diameter, sand- and clay-size fraction, and plasticity index. Specific gravity of solids ranged from 2.68 to 2.89, without correction for salt content, and showed a tendency to be directly related to wet unit weight and inversely related to porosity. Wet unit weight ranged from 1.23 to 1.86 g/cm³ and was inversely related to porosity. All samples, except one, were effectively 100 percent saturated. Water content ranged from 37 to 237 percent dry weight, corresponding to porosities of 51 to 86 percent. Surface porosities averaged by area ranged from 72 to 86 percent. Straight-line relationships between porosity and clay-size fraction and also the logarithm of cohesion are related to relative rates of deposition in the different areas. Liquid limit ranged from 25 to 109 percent and plastic limit from 15 to 46 percent, with most values between, respectively, 50 to 80 percent and 20 to 30 percent. Most samples were highly plastic; extremes of plasticity index were 1.6 and 81. In surface sediments, water content always was greater than liquid limit. Liquidity indices commonly were about 200 percent, with a few values greater than 1,200 percent. Cohesion ranged from 4.2 to 234 g/cm² in "undisturbed" samples. The mean of surface cohesion measurements in predominantly terrigenous sediments was about 20 g/cm², and in calcareous sediments about 40 g/cm². Sensitivities of 1.6 to 26 are reported. Porosity appeared directly related to sensitivity. Activity ranged from 0.06 to 1.7 with most values between 0.25 and 1.25. Moduli of elasticity, computed from compressive strength test measurements, ranged from 0 to 870 g/cm².



FOREWORD

This second report on Investigations of Deep-Sea Sediment Cores is a comprehensive study of the laboratory measurements of the mass physical properties of 35 deep-sea sediment cores from various oceanic areas of the world.

Procedures described for marine sediment core analysis are those being used at the U. S. Navy Hydrographic Office.

Results of this study are presented in this report through the cooperation of the Bureau of Public Roads and three establishments within the Navy: the Hydrographic Office, the Bureau of Yards and Docks, and the Navy Electronics Laboratory.



E. C. STEPHAN
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NOTATION

a_c	activity ($\text{PI}/\text{clay-size fraction}$)
B	liquidity index ($w - \text{PL}/\text{PI}$)
c	apparent cohesion
C_a	area or Kerf ratio
C_c	compression index
C_i	inside clearance ratio
C_o	outside clearance ratio
D_e	minimum inside diameter of core nose
D_s	minimum inside diameter of core barrel or liner
D_t	outside diameter of core barrel
D_w	maximum outside diameter of core nose
e	void ratio (V_v/V_s)
e_i	initial void ratio
e_f	final void ratio
$e_{sat.}$	void ratio at 100 percent saturation ($G_{sw}/100$)
G_s	specific gravity of solid particles
G_t	specific gravity of distilled water at temperature t
H	penetration of corer
l	liter
L_g	distance from top of core to core nose cutting edge
LL	liquid limit
Md	median diameter
n	porosity, in percent (V_v/V)
PI	plasticity index ($\text{LL}-\text{PL}$)
PL	plastic limit
p	pressure

NOTATION (Cont'd)

P_c	compressive strength
P_f	final pressure
P_i	initial pressure
pcf	pounds per cubic foot
psi	pounds per square inch
R_g	gross recovery ratio
S	percent saturation of void space
S_t	sensitivity (undisturbed strength/remolded strength)
s	shear strength
V	volume of sediment mass
V_s	volume of solid particles
V_v	volume of voids
W_c	weight of sample container
W_s	dry (110°C) weight of solid particles
W_w	weight of water in a given sediment mass
W_1	weight of volumetric flask, sediment, and air-free water
W_2	weight of volumetric flask and air-free water
W_3	weight of sample plus container
w	water content in percent dry (110°C) weight
wc	water content in percent wet weight ($W_s + W_w$)
γ	unit weight
γ_m	wet or mass unit weight of sediment
γ_w	unit weight of water
μ	micron (0.001 mm)
ρ	density
$\bar{\sigma}$	effective stress
ϕ	phi (-log ₂ particle diameter in mm) or, angle of shearing resistance
ϕ_{50}	phi median diameter

I. INTRODUCTION AND ACKNOWLEDGMENTS

In a recent book on marine sediments, Shepard (Shepard and others, 1960, p. 3-4) states that there are two principal methods to obtain characteristics of sediments sampled in the field: (1) microscopic and laboratory investigation of the constituents, and (2) physical and geochemical investigation of the constituents, for example, x-ray study, polarography, and electron microscopy. I would add an important third method, one that has been largely neglected by marine geologists: (3) physical and chemical properties of the sediment in mass. This paper considers only the mass physical properties of 35 sediment cores collected by the U. S. Navy Hydrographic Office during 1958 and 1959; it is the second in a series of three principal reports on these cores.

The first paper (Richards, 1961, -- hereafter called part one) described and discussed sampling procedure, laboratory preparation of samples for the tests, shear strength related to depth in the cores, and the practical application of shear strength and data derived from laboratory consolidation tests in the computation of bearing capacity and consolidation of sea-floor sediments when overstressed by an applied load. A third paper, in preparation, considers results of measured (laboratory) and computed (sedimentation compression -- Terzaghi, 1941, p. 215) pressure-void ratio relationships, and the influence of overburden pressure on the shear strength.

Soil mechanics terms and symbols in general conform to those published in 1958 by the joint Committee on Glossary of Terms and Definitions in Soil Mechanics of the American Society of Civil Engineers (ASCE) and the American Society for Testing Materials (ASTM). Notation has been presented. All logarithms are to the base ten unless otherwise noted.

Most of the tests reported were performed in the Soil Mechanics Laboratory of the Bureau of Yards and Docks (BUDOCKS) by personnel under the direction of Mr. C. M. Yeomans. Practically all of the size analyses and a few other tests were performed in the oceanographic laboratory of the Hydrographic Office under the direction of Mr. J. H. Recknagel. Clay mineralogy and certain other mineralogical analyses were made in the Physical Research Division of the Bureau of Public Roads under the direction of Mr. E. B. Kinter.

In addition to those persons and organizations previously acknowledged in part one, I wish to thank Messrs. E. B. Kinter and S. Diamond, Bureau of Public Roads, for performing mineralogical analyses. Dr. J. C. Hathaway, U. S. Geological Survey in Denver, reviewed the mineralogy and activity section of this report, made helpful suggestions in light of recent advances in this field, and kindly made available an unpublished report. I am particularly grateful to Mr. G. H. Keller of the

Hydrographic Office for his close cooperation and assistance in nearly all phases of the study after May 1958, and to my colleagues at the Navy Electronics Laboratory for helpful discussions on different aspects of the investigation. I also thank the numerous individuals who helped in the compilation of the data tables, performed typing, and drafted the final illustrations.

The report was written while I was a National Academy of Sciences-National Research Council Postdoctoral Resident Research Associate at the U. S. Navy Electronics Laboratory in San Diego, California.* I am pleased to acknowledge the cheerful support of many persons at the laboratory, especially Dr. E. L. Hamilton, my advisor, for his continued encouragement.

A preliminary draft of this paper was reviewed by Mr. P. P. Brown, Dr. G. H. Curl, Dr. E. L. Hamilton, Mr. G. H. Keller, Dr. R. T. Martin, Mr. D. G. Moore, Dr. G. Shumway, and Mr. C. M. Yeomans, to whom I am appreciative for helpful suggestions.

* Author is presently a member of the staff of Office of Naval Research Branch Office, American Embassy, London, England.

II. CORE COLLECTION

Thirty-five sediment cores were collected from eight different areas of the continental shelf, continental slope, and deep-sea floor in the North Atlantic Ocean, West Mediterranean Sea, and Central Pacific Ocean (Fig. 1). Relation of cores within each area is shown in Figure 2; geographic coordinates cannot be published at this time.

Table 1 summarizes the equipment used to obtain the cores, sonic depth of water, and pertinent information about each core. The name of the corer refers to the U. S. Hydrographic Office (1955, p. 54-66) model of corers originally designed or described by Kullenberg (1947), Ewing (Heezen, 1952), and Phleger (Phleger and Parker, 1951, p. 3-5). The Hydroplastic corer was developed in the Hydrographic Office for use in this program (Richards, 1960; Richards and Keller, 1961).

The gross recovery ratio (Hvorslev, 1949, p. 100), R_g , listed in Table 1 is related to the distance from the top of the core to the core nose cutting edge, L_g , and the penetration of the corer, H , by

$$R_g = \frac{L_g}{H} \quad (1)$$

This ratio is assumed to be 100 percent for piston cores. For gravity cores, the gross recovery ratio appears dependent on the clearance and area ratios of the corer (part one). In Table 1, this ratio is based on the extreme condition that core shortening is the same throughout the length of the core and that core penetration equals corer penetration. A further discussion of the problem has been given in part one.

No corrections for core shortening are applied to the data presented. For each and every core, the distance given in tables and graphs is the distance from the top of the core measured in the laboratory.

Hvorslev (1949, p. 105-109) defined ratios affecting performance of corers as

$$C_i = \frac{D_s - D_e}{D_e} \quad (2)$$

where C_i is the inside clearance ratio that controls inside friction, D_s is the minimum inside diameter of the core barrel or liner, and D_e is the minimum inside diameter of

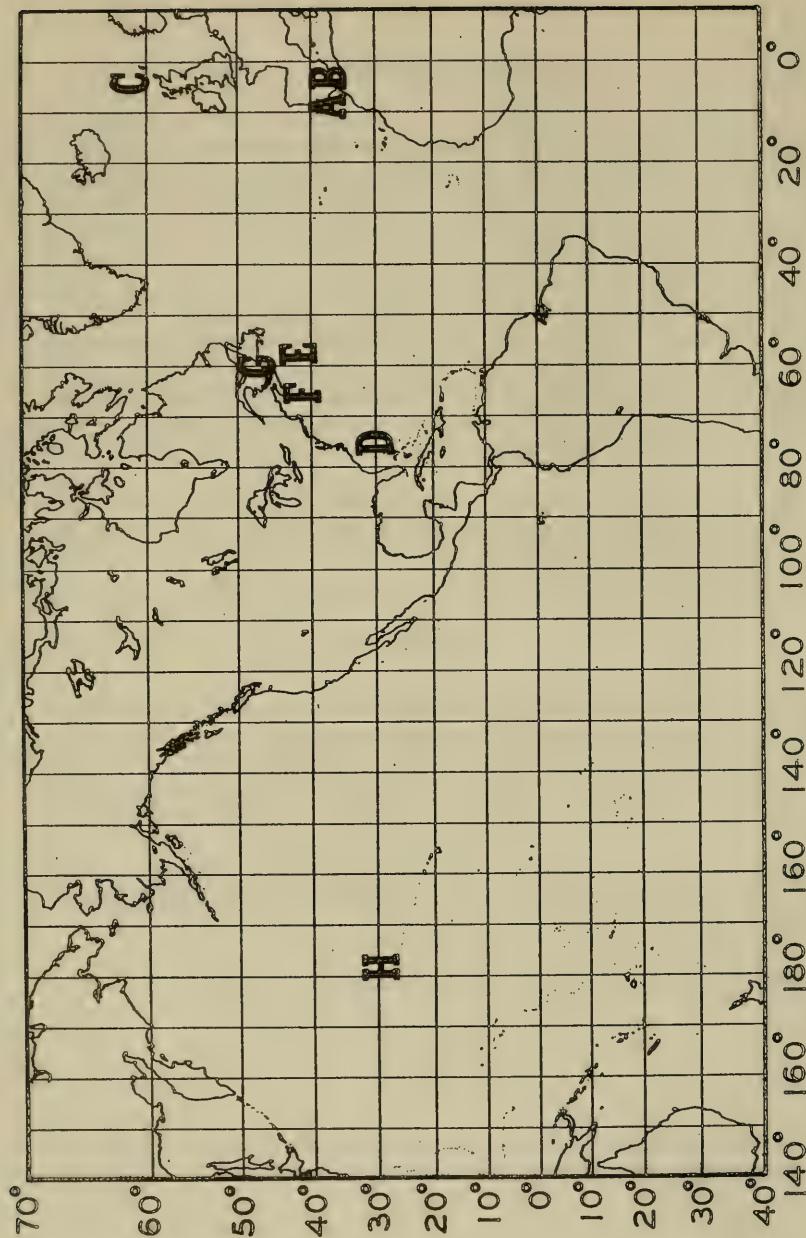


FIGURE 1. LOCATION OF AREAS WHERE CORES WERE COLLECTED

AREA 23
A

31 33
0 10 20
NAUT. MILES

AREA B

83 87 85

0 10 20 30 40 50
NAUT. MILES

AREA C

20
19
18
16

0 50
NAUT MILES

AREA D

2 19

0 10 20 30
NAUT. MILES

AREA E
47

46

0 48 0.5
NAUT. MILES

AREA F

15
16-14
13
10

12
0 1 2 3
NAUT. MILES

6

11

AREA G

2-6

8-11
0 50
NAUT. MILES

FIGURE 2. RELATION OF CORES WITHIN EACH AREA

TABLE 1. CORE AND CORER SUMMARY

Area (No.)	Core Depth ¹ (m)	Predominant Sediment ² Type	Core Diameter (cm)	Core Length (cm)	Estimated Penetra- tion (cm)	Gross Recovery Ratio, R_g ³ (%)	Corer Type ³ $G = \text{Gravity}$ $P = \text{Piston}$	Core Nose			Collector
								Inside Clearance Ratio, C_i (%)	Outside Clearance Ratio, C_o (%)	Area Ratio, C_a (%)	
A	23	T, clayey silt	4.75	76	150	50	Kullenberg-G	3.6	10.1	105.5	A.F. Richards
	31	T, clayey silt	4.75	104	150	68	Kullenberg-G	3.6	10.1	105.5	"
	33	T, silty clay	4.75	97	150	63	Kullenberg-G	3.6	10.1	105.5	"
B	83	T, silty clay & clayey silt	4.75	102	180	57	Kullenberg-G	3.6	10.1	105.5	A.F. Richards
	85	T, clayey silt	4.75	79	180	43	Kullenberg-G	3.6	10.1	105.5	"
	87	T, clayey silt	4.75	81	180	44	Kullenberg-G	3.6	10.1	105.5	"
C	16	T, clayey silt	4.75	79	180	100	Kullenberg-P	3.6	10.1	105.5	A.F. Richards
	18	T, clayey silt	4.75	117	170	100	Kullenberg-P	3.6	10.1	105.5	"
	19	T, clayey silt	4.75	76	120	100	Kullenberg-P	3.6	10.1	105.5	"
	20	T, clayey silt	4.75	51	120	100	Kullenberg-P	3.6	10.1	105.5	"
	1	C&T, clayey silt	2.5	36	75	60	Phleger-G	10.2	0	62.2	S.W. Oliver
D	1240	C&T, sand-silt-	2.5	30	90	33	Phleger-G	10.2	0	62.2	"
	2010	C&T, clayey silt	6.35	511	610	100	Ewing-P	0.6	22.7	84.5	A.F. Richards
1	2550	C, clayey silt	6.35								
E	46	T, clayey silt	4.75	142	180	78	Kullenberg-G	3.6	10.1	105.5	G.H. Knoop, Jr.
	47	T, clayey silt	4.75	157	180	86	Kullenberg-G	3.6	10.1	105.5	"
	48	T, clayey silt	4.75	109	180	60	Kullenberg-G	3.6	10.1	105.5	"

¹Uncorrected sonic depth. One meter equals 0.547 fathoms or 3.28 U.S. feet.²T = terrigenous source, C = calcareous source, and PC = pelagic clay source of material.³See text.

TABLE 1. CORE AND CORER SUMMARY (Cont'd)

Core Area (No.)	Approx. Water Depth ¹ (m)	Predominant Sediment ² Type	Core Diameter (cm)	Core Length (cm)	Estimated Penetration Ratio, R_g (%)	Gross Recovery Ratio, R_3 (%)	Corer Type ³ G = Gravity P = Piston	Core Nose				Collector
								Inside Clearance Ratio, C_i (%)	Outside Clearance Ratio, C_o (%)	Area Ratio, C_a (%)	Core Nose	
F	6	2270	T _r , clayey silt	8.2	269	280	100	Hydroplastic-G	1.3	13.4	56.3	A.F. Richards
	10	2450	T _r , clayey silt	4.75	175	180	100	Kullenberg-G	3.6	10.1	105.5	"
	11	2450	T _r , clayey silt	8.2	152	-	-	Hydroplastic-G	1.3	13.4	56.3	"
	12	2430	T _r , clayey silt	4.75	168	170	96	Kullenberg-G	3.6	10.1	105.5	"
	13	2415	T _r , clayey silt	4.75	142	140	100	Kullenberg-G	3.6	10.1	105.5	"
	14	2395	T _r , silty clay	4.75	173	140	100	Kullenberg-G	3.6	10.1	105.5	"
	15	2415	T _r , silty clay	4.75	155	120	100	Kullenberg-G	3.6	10.1	105.5	"
	16	2415	T _r , silty clay	4.75	170	130	100	Kullenberg-G	3.6	10.1	105.5	"
G	2	455	T _r , silty clay	6.35	557	610	100	Ewing-P	0.6	22.7	84.5	G.H. Keller
	3	455	T _r , silty clay	8.1	152	400	39	Hydroplastic-G	1.3	13.4	56.3	"
	4	455	T _r , silty clay	8.1	229	370	100	Hydroplastic-P	1.3	13.4	56.3	"
	5	455	T _r , silty clay	6.35	1204	1310	100	Ewing-P	0.6	22.7	84.5	"
	6	455	T _r , silty clay	8.1	152	210	71	Hydroplastic-G	1.3	13.4	56.3	"
	8	455	T _r , silty clay	8.1	244	300	100	Hydroplastic-P	1.3	13.4	56.3	"
	9	455	T _r , silty clay	8.1	137	210	64	Hydroplastic-G	1.3	13.4	56.3	"
	10	455	T _r , silty clay	8.1	81	240	75	Hydroplastic-G	1.3	13.4	56.3	"
	11	455	T _r , silty clay	8.1	122	210	57	Hydroplastic-G	1.3	13.4	56.3	"
	12	5120	PC _r , silty clay	6.35	511	-	100	Ewing-P	0.6	22.7	84.5	R.H. Michel
H	13	5120	PC _r , silty clay	4.75	142	-	-	Kullenberg-G	3.6	10.1	105.5	"

the core nose or core cutter;

$$C_o = \frac{D_w - D_t}{D_t} \quad (3)$$

where C_o is the outside clearance ratio that controls outside friction, D_w is the maximum outside diameter of the core nose, and D_t is the outside diameter of the core barrel; and

$$C_a = \frac{D_w^2 - D_e^2}{D_e^2} \approx \frac{\text{Volume of displaced sediment}}{\text{volume of the sample}} \quad (4)$$

where C_a is the area or Kerf ratio. These ratios, shown in Table 1, are significant, and their application to the cores collected in this program has been discussed in part one, where it was concluded that all cores are, strictly speaking, disturbed samples; those obtained with the Hydroplastic corer appear to be among the least disturbed.

III. SEDIMENT CLASSIFICATION

Index or classification properties of sediments used in this report are derived from measurements of the grain size, water content, liquid limit, and plastic limit; the latter two collectively are called Atterberg limits.

Geologists and civil engineers in the United States commonly use slightly different grain-size scales, respectively the Wentworth (1922) scale and the Massachusetts Institute of Technology or M.I.T. scale developed by Gilboy (Glossop and Skempton, 1945). These scales are compared and the scale used in this paper is given in Table 2. At the Hydrographic Office, the distinction between silts and sands follows Wentworth and is made at 62.5μ or about 4ϕ units¹. Clay-size particles are of particular significance in fine-grained sediments and the maximum size of clay minerals (comprising most of the clay-size fraction) appears to be nearer 2 than 4μ according to Grim (1942, p. 229; 1953, p. 1)².

TABLE 2. COMPARISON OF GRAIN-SIZE SCALES

	Wentworth Scale		M.I.T. Scale		Scale Used In This Paper	
	microns	phi ¹	microns	phi	microns	phi
Sand	2000 to 62.5	-1 to 4	2000 to 60	-1 to 4.06	2000 to 62.5	-1 to 4
Silt	62.5 to 3.9	4 to 8	60 to 2	4.06 to 9	62.5 to 2	4 to 9
Clay	<3.9	>8	<2	>9	<2	>9

¹ After Krumbein (1936)

Consequently, the M.I.T. silt-clay separation at 2μ or 9ϕ is preferred (Table 2). Nomenclature (Fig. 3) follows the triangular diagram system devised by Shepard (1954). In Table 1, the modifying prefix to the name of the sediment is based on its predominant source.

¹ In the phi notation (Krumbein, 1934, p. 76), phi is equal to the negative logarithm to the base two of the diameter in millimeters.

² Baver (1940, p. 14-17) relates the development of 2μ as the upper limit for clay. On the other hand, Mielenz and King (1955, p. 213-216) summarize evidence for larger clay-size particles.

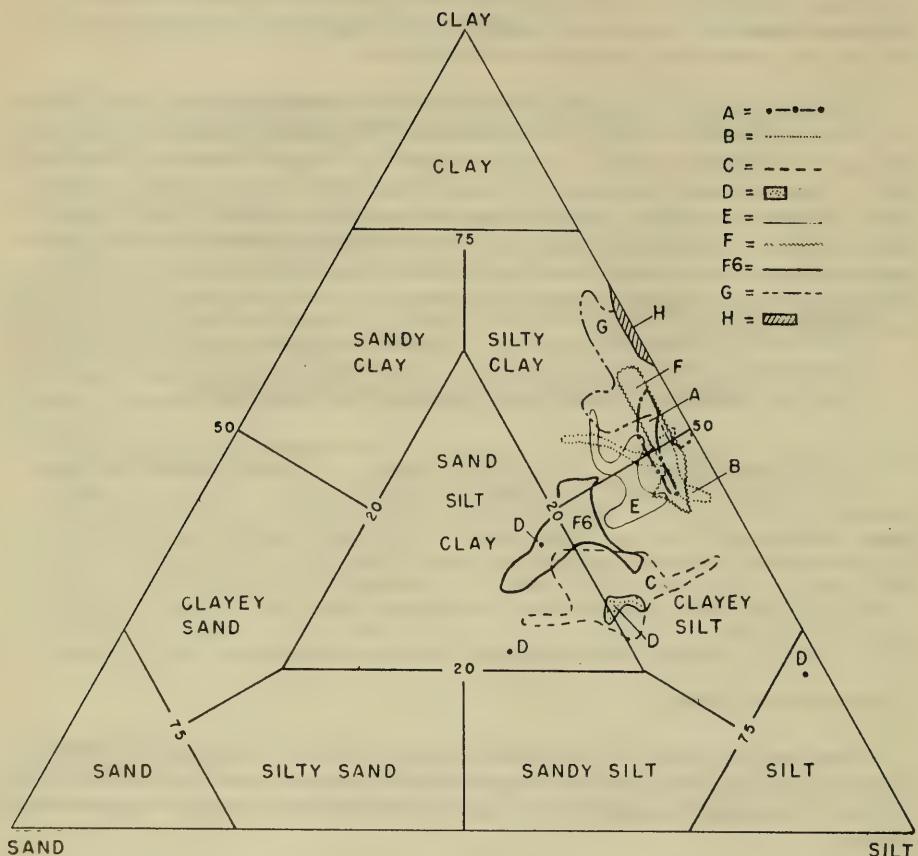


FIGURE 3. NOMENCLATURE OF SEDIMENTS BY AREA. POINTS OUTSIDE OF AREA D INDICATED BY LETTER

Atterberg (1911, p. 20-22) originally defined seven limits of plasticity. Two of his limits, the liquid limit ("Fließgrenze") and the "roll-out" limit ("Ausröllgrenze")--now called the plastic limit, were adapted by Terzaghi (1925a, p. 20-29; 1925b, p. 799) for use in soil mechanics. Liquid limit is defined (ASCE) as the water content (in percent of oven-dry weight) corresponding to the arbitrary limit between the liquid and plastic states of consistency of a sediment; plastic limit is the water content corresponding to an arbitrary limit between the plastic and semisolid states. The numerical difference between the liquid and plastic limits was called the plasticity number by Atterberg (1911, p. 29-30; 1913, p. 293); it is now known as the plasticity index. Determination of Atterberg limits is discussed later.

A system of classification developed by Casagrande (1948) for application to design and construction of airfields uses a plasticity chart relating plasticity index to liquid limit (Fig. 4). In this chart the A-line represents an important empirical boundary (Casagrande, 1948, p. 919) between typical inorganic clays generally above the line, and plastic sediments containing organic colloids and typical inorganic silts and silty clays below it. The plasticity chart shows two especially interesting relationships that have been emphasized by Terzaghi (1955, p. 564): (1) Atterberg limits of grain-size fractions of ground minerals plot in a straight line roughly parallel to the A-line and may be located above or below the line depending on mineralogical composition, and (2) points representing different samples from a geologically well-defined sedimentary deposit also are located on such a line because of the likelihood of similar mineralogical composition of the clay-size fraction. A corollary of the last statement is that if points representing two members in the plasticity chart are located on different lines then it is almost certain that the sediments have different sources (Terzaghi, 1955, p. 565). Trask and Rolston (1950; 1951, p. 1092) confirmed these relationships for San Francisco Bay sediments. These relationships also are valid for the sediments investigated. All sediments shown in Figure 4, with two exceptions, have a similar depositional environment, despite the wide variation in water depth and geographic location. These sediments are composed of terrigenous material and plot on a line above and parallel to the A-line. One of the two exceptions was the Area D cores, which are of calcareous material, the other was core B 83, which was collected farthest from land and probably consists of mixed terrigenous material and deep-sea (Foraminifera) ooze; samples from core B 83 plot as points on and below the A-line between liquid limits of 50 and 60 percent. The marked difference in liquid limit and plasticity index of Area D gravity cores 1 and 2 (very low plasticity index) and piston core 1 (high plasticity index) probably results from the greater proportion of sand-size material in the gravity cores. It is noteworthy that samples from the calcareous D 1p core, although plotting above the A-line, fall on a dissimilar slope compared to those samples having a terrigenous origin. The sediments in Area F with low liquid limit are exclusively from core 6 and have different physical properties compared to other cores from the same area (see Fig. 3).

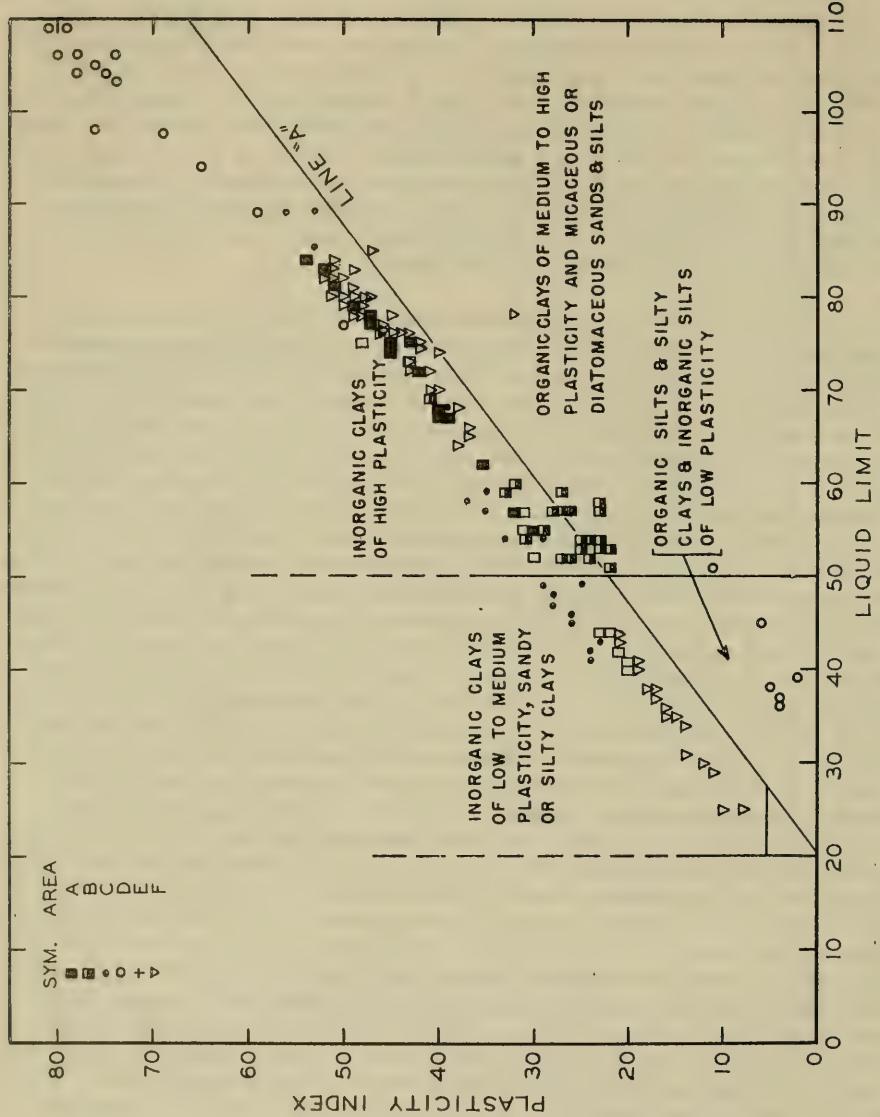


FIGURE 4. PLASTICITY CHART. THE A-LINE IS AN EMPIRICAL BOUNDARY,
SEE TEXT FOR DISCUSSION

In conclusion, the use of a plasticity chart appears to provide rapid identification of similar and dissimilar depositional environments. It has been suggested (Richards, 1959) that use of a plasticity chart together with a triangular diagram provides a more satisfactory basis of marine cohesive sediment classification than by using grain size alone.

IV. MASS PROPERTIES

A. INTRODUCTION

Mass physical and classification properties of more than 700 samples from 35 cores were determined in the laboratory. The tests included measurement of: (1) grain size, (2) specific gravity of solids, (3) wet unit weight, (4) water content, (5) degree of pore space water saturation, (6) liquid and plastic limits, (7) void ratio, and (8) compressive and/or vane shear strength. From these measurements the following properties were computed: (1) percentage of sand-, silt-, and clay-size particles, (2) grain median diameter, (3) void ratio at 100 percent saturation, (4) porosity, (5) liquidity index, (6) plasticity index, (7) cohesion, (8) sensitivity, (9) activity, and (10) modulus of elasticity. The mineralogy of a few samples also was investigated.

A unit volume of any deep-sea sediment, in simple terms following the conception of Rosenqvist (1955, p. 3), may be considered a two-phase system consisting of: inorganic and organic particulate matter, principally mineral grains and skeletons of small plants and animals, and water containing soluble salts. It was not feasible to determine the quantity of salt (loosely-speaking salinity) of the interstitial water in the laboratory program, and no salt corrections have been applied. Computation of percentage of water saturation shows that the void space of samples tested can be considered 100 percent saturated with water. Consequently, water content is expressed as porosity or the volumetric weight of water. Organic content was low and gas, when it existed, was considered a negligible quantity.

Parameters measured in the laboratory are related to the measured distance below the top of each core. The length of each sample tested is graphically shown in Plates I through XXXV by a vertical line. Mid-points of sample lines are connected to show the profile, except for specific gravity where minor variations with depth would be obscured. In the plates, the abbreviations pcf and psi respectively indicate pounds per cubic foot and pounds per square inch; explanation of symbols is given in text and under notation; unless specified, all cohesions were computed from compressive strength tests. The pattern for showing the percentage of sand-, silt-, and clay-size fraction closely follows a standard soil mechanics representation (Anonymous, 1960).

B. GRAIN SIZE

Procedure -- Most samples were mechanically analyzed in the Hydrographic Office Laboratory using the following method. A 25 g representative sample having a natural water content was placed in a beaker of water and stirred by hand. The resulting suspension then was poured into a milkshake container and mechanically

mixed for 15 minutes. The sample next was wet sieved in a U. S. Standard 230 mesh (4 phi) sieve. The size fraction coarser than 4 ϕ was oven-dried and then sieved again for 15 minutes using a nest of sieves (openings: 2 mm, 1 mm, 0.5 mm, 250 μ , 125 μ , and 62.5 μ) in an American Instrument shaker. The size fraction finer than 4 ϕ was placed in a cylinder of water or a solution of either sodium hexametaphosphate or sodium metaphosphate (10 g/l), and allowed to stand for several hours. Usually the samples in a pipette analysis, which in general follows the procedure of Krumbein and Pettijohn (1938, p. 166-172), were selected only at settlement times corresponding to 4, 6, and 9 phi. A pipette analysis was not made if the sample contained 85 percent or more sand-size material. Results of the grain-size analysis were graphed to show a cumulative frequency distribution by weight, from which the phi median diameter, ϕ_{50} , was selected. The few grain-size analyses made in the BUDOCKS Soil Laboratory in general follow ASTM designation D422-54T (ASTM, 1958, p. 1119-1129), except that the sample was not dried prior to testing. Several identical test samples were processed by each laboratory for a check of accuracy and precision; differences in the percentage of sand, silt, clay, and median diameter of the samples were negligible.

Practically all of the samples analyzed were sufficiently fine grained to make the 75th or 84th percentiles unobtainable by 9 ϕ . Consequently, it was impossible to compute either the Trask (1932, p. 70-72) sorting coefficient or the phi deviation measure of Inman (1952). In some instances, even the 50th percentile had to be estimated from an extrapolation of the cumulative curve. Converting phi units to microns was facilitated using a conversion table (Page, 1955).

Results -- Cores from Areas C and D and core F 6 were predominantly composed of clayey silt-size particles with more than 10 percent sand-size material (Fig. 3). Cores from Areas A, B, E, and F were predominantly composed of both silty clay- and clayey silt-size particles with less than 10 percent sand-size material. Area G and H cores almost entirely consisted of silty clay with less than 5 percent sand-size grains.

The correlation between porosity and grain median diameter is shown as a band with an eye-fitted mean line when void ratio³ is related to median diameter in phi units (Fig. 5). This relationship is much less obvious when porosity instead of void ratio is related to grain median diameter, and when samples from other areas (Shumway, 1960; Sutton and others, 1957; and Trask, 1953) also are plotted (Fig. 6). (In converting water contents to porosity -- Table 16 in Trask 1953, a grain density of 2.7 was assumed; a density of 2.6 instead of 2.7 will change the porosity less than one percent). The range of values shown suggests that when more figures(such as shown in a

³ Ratio of volume of voids to the volume of solids.

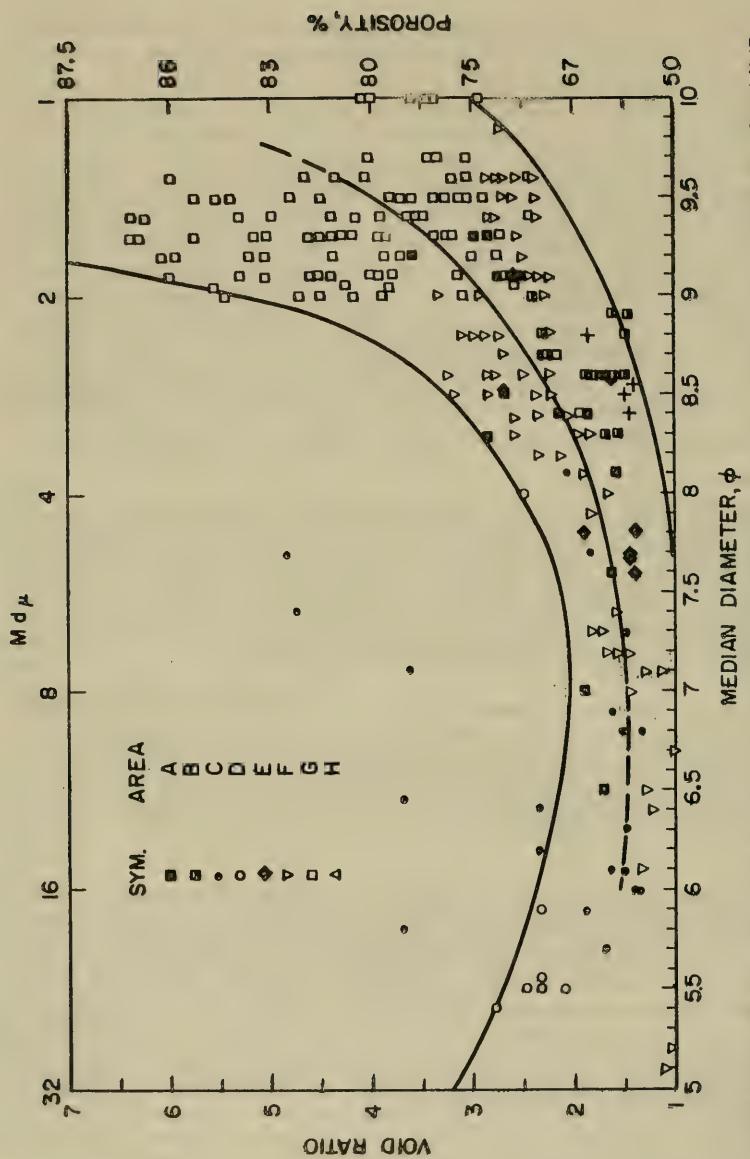


FIGURE 5. RELATION OF VOID RATIO TO MEDIAN DIAMETER. (AN EYE-FITTED CORRELATION LINE IS SHOWN BETWEEN TWO LINES DENOTING GENERALIZED LIMITS)

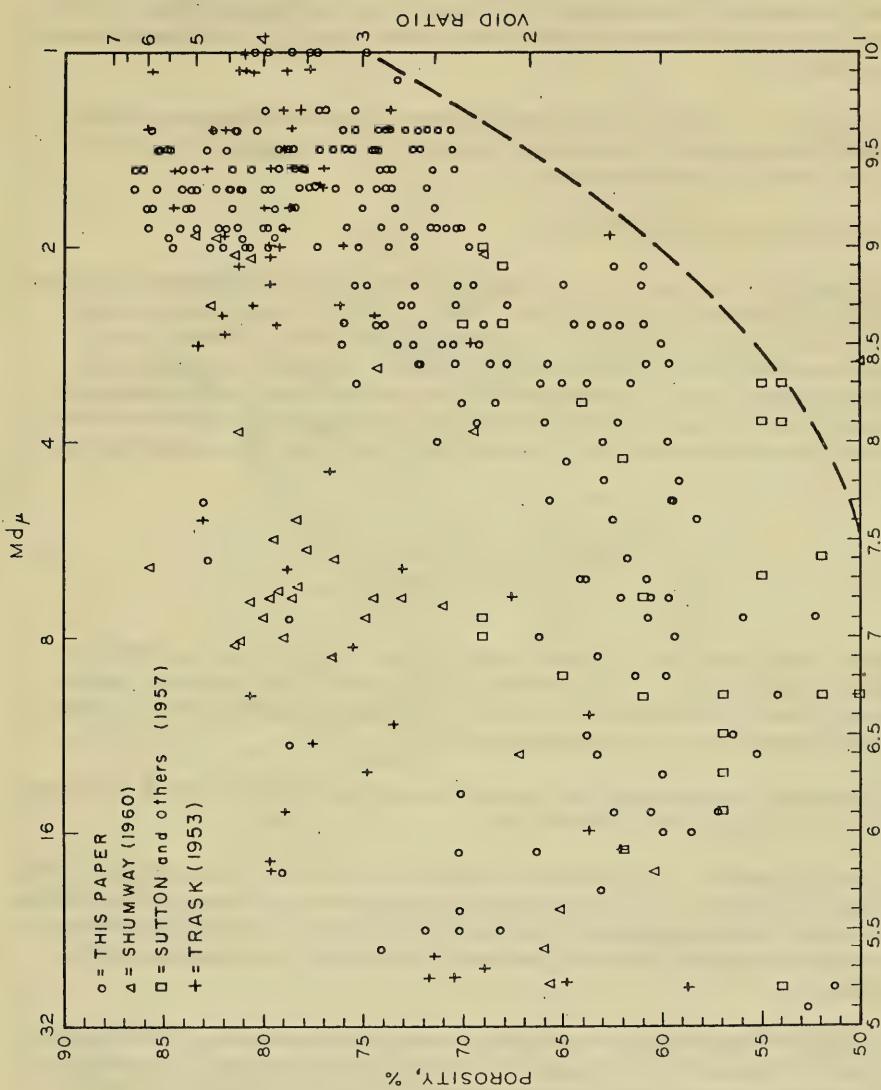


FIGURE 6. RELATION OF POROSITY TO MEDIAN DIAMETER. (THE DASHED LINE REPRESENTS A GENERALIZED LIMIT)

band by Emery, 1960, Fig. 210) are plotted the only clear relationship remaining will be that fine-grained sediments ($Md_f > 7.5$) do not have very low porosities, as indicated by the empirical dashed boundary line extending from 7.5 ϕ to 75 percent porosity in Figure 6.

Discussion -- Particle size is inversely related to particle surface area and to interstitial water content. This relation is graphically shown in Figure 5 and also in Figure 9, which will be discussed later.

C. SPECIFIC GRAVITY OF SOLIDS

Procedure -- Most samples were analyzed in the BUDOCKS Laboratory following ASTM test designation D 854-58 (ASTM, 1958, p. 1149-1151); the same procedure was used on those samples analyzed at the Hydrographic Office. Briefly, a 25 g sample was oven-dried at 110°C overnight, cooled in a desiccator, weighed, and placed in distilled water. Entrapped air was removed by subjecting the sample in a volumetric flask to a partial vacuum. Afterwards, the flask was filled with air-free distilled water and then reweighed. Specific gravity of solids, G_s , was determined from

$$G_s = \frac{W_s G_t}{W_s - W_1 + W_2} \quad (5)$$

where W_s is the dry weight of solid particles, G_t is the specific gravity of distilled water at temperature t , W_1 is the weight of the volumetric flask, sediment, and air-free water, and W_2 is the weight of the volumetric flask and air-free water. Values reported are based on a water temperature of 20°C.

Corrections for salt content in the specific gravities were not made. A discussion of salt corrections is given in Appendix A.

Although earlier it was stated that all samples were entirely water saturated, when boiling off entrapped air an occasional sample was observed to liberate gas after all the air presumably had been expelled. Neither quantity or quality of gas was determined; the amount is considered less than 5 percent of the degree of saturation and of little importance.

Results -- Specific gravities of solids of nearly 500 samples (Fig. 7) fall between the limits of 2.68 and 2.89. The bulk of sample values are between 2.72 and 2.82. An approximate average for all samples is about 2.76 to 2.77. There is a tendency for specific gravities to be inversely related to the porosity, or water content, and

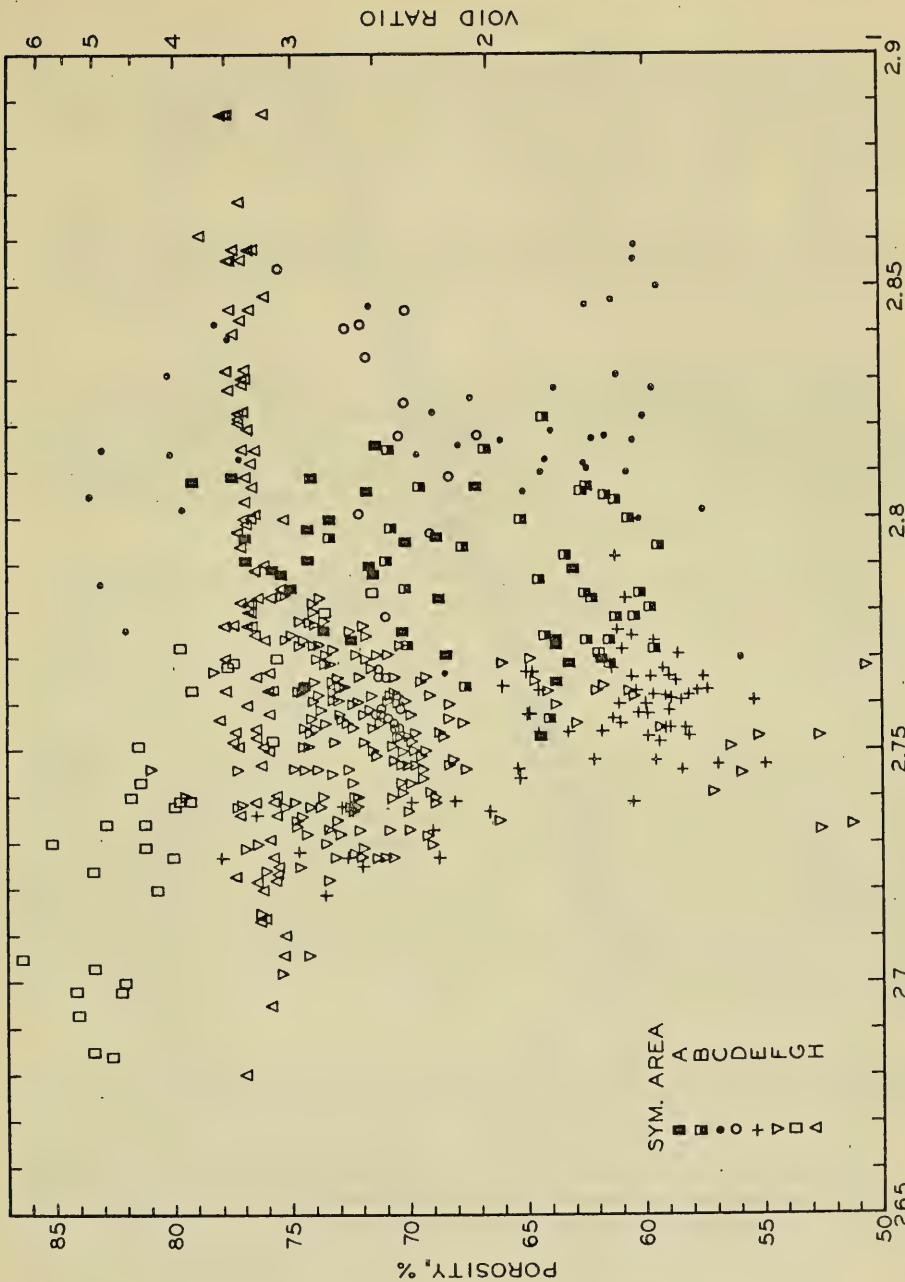


FIGURE 7. RELATION OF POROSITY TO SPECIFIC GRAVITY OF SOLIDS

directly related to the wet unit weight (Fig. 8). A particularly clear example is shown in the graph of core F 6, Plate XVII. At a depth of 208 to 248 cm (82 to 90 in), the sand-size fraction decreases from about 37 to 25 percent. Particle specific gravity decreases from a normal value of about 2.76 to 2.73 over this interval.

Discussion -- Few comparative values of the specific gravities of solids of deep-sea sediments are available. Sykes (1960, p. 31) measured specific gravities, which were not corrected for salt content, ranging from 2.78 to 2.83 in clay-size sediments.

D. WET UNIT WEIGHT

Procedure -- It is appropriate to first remark that the term density as used in physics rarely is used by soil engineers. Density, ρ , is defined as mass per unit volume, while in soil mechanics unit weight, γ , is defined as weight per unit volume. The two terms are related by equating unit weight to the product of density and the acceleration of gravity, g , ($\gamma = \rho g$). The reader is referred to soil mechanics texts (for example, Hough, 1957, p. 27; Spangler, 1960, p. 55) for further discussion.

Wet or mass unit weight, γ_m , is defined as the weight per unit of total volume of sediment mass, irrespective of the degree of saturation (ASCE), or

$$\gamma_m = \frac{W_3 - W_c}{V} \quad (6)$$

where W_3 is the weight of the sample plus container, W_c is the weight of the container alone, and V is the volume of sediment in the container. The degree or percentage of saturation is the ratio of the volume of water in a given sediment mass to the total volume of intergranular space or voids (ASCE); its determination is given by equation 16. Although wet unit weight is semantically correct, all samples at the time of test were sufficiently close to 100 percent saturation to permit the use of the term saturated unit weight, which represents the in-place unit weight or bulk density. Values are reproducible only to 0.1 because of the difficulty in eliminating very small voids between the sample and cylinder wall with consequent loss of precision in the volumetric measurement.

Results -- Values of wet unit weight range from a maximum of 1.86 g/cm^3 at 50.35 percent porosity in Area F to a minimum of 1.23 g/cm^3 at 86.4 percent porosity in Area G.

The straight-line relationship of wet unit weight to porosity (Fig. 8) previously has been shown by Hamilton and Menard (1956, p. 760) and Nafe and Drake (1957, p. 542),

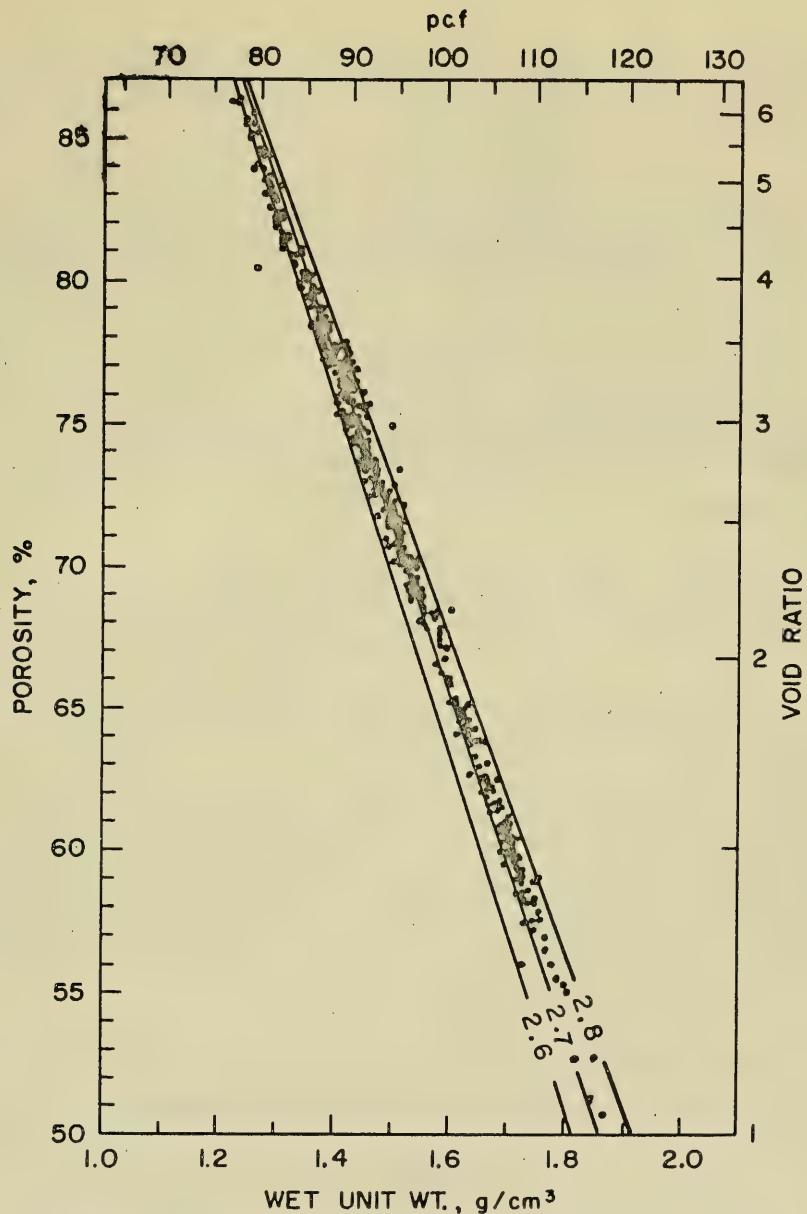


FIGURE 8. RELATION OF POROSITY TO WET UNIT WEIGHT. (SEE TEXT FOR EXPLANATION OF LINES LABELED 2.6, 2.7, and 2.8)

but with fewer data. In Figure 8, lines of equal specific gravity (2.8, 2.7, 2.6) meet at 100 percent porosity and 1.03 g/cm^3 , the unit weight of sea water; at zero porosity specific gravity equals unit weight.

Discussion -- Ratcliffe (1960, p. 1538) reports quite a different relationship. His wet density-water content (in percent wet weight) line (Ratcliffe, Fig. 4) intersects zero water content (zero porosity) at about 2.1 g/cm^3 , and at 1.03 g/cm^3 a water content of about 82 percent is indicated, which corresponds to a porosity of only 91 or 92 percent depending on whether 2.1 or 2.35 g/cm^3 is used for the particle density. Ratcliffe's data indicate abnormally low water contents, suggesting that the sediment tested was desiccated. Alternatively, a different test procedure may account for different values. The likelihood of this second possibility is increased with reference to wet unit weights and water contents of selected samples presented by von Herzen and Maxwell (1959, p. 1562), whose values fall to the left (low water content) of the 2.6 particle specific gravity straight line in Figure 8.

E. WATER CONTENT

Introduction -- Water content, w , used herein is the ratio, in percent, of the weight of water in a given sediment mass, W_w , to the weight of the oven-dry solid particles, W_s (ASCE). It is determined by weighing a representative portion of the sample, oven-drying at 110°C overnight, cooling in a desiccator, and reweighing.

Lambe (1950, p. 494-495; 1951, p. 10-12) demonstrated that variations of temperature in different locations in non-heat distributing "constant-temperature" ovens may exceed 100°C ; and that variations in the amount of water driven off at any given temperature are greatest in fine-grained sediments having a high colloid content. Investigators would do well to follow the example of Correns (1937, p. 38) and specify the percentage deviation from 105° or 110°C whenever possible. Temperature variations of 0° to -41° from 110°C were found in the BUDOCKS oven by C. M. Yeomans (1961, written communication), corresponding to a precision of water content measurement of about one percentage point. Although reproducibility may be less than indicated by the number of significant figures given in this report, these figures are retained following engineering convention.

Corrections have not been made for salt content; values of water content consequently are slightly low.

In addition to water content (also called moisture content), previously defined as

$$w = \frac{W_w}{W_s} \times 100, \quad (7)$$

two other measures commonly are employed. Geologists often use

$$w_c = \frac{W_w}{W_s + W_w} \times 100 \quad (8)$$

where w_c is the water content expressed as a percentage of the total wet weight $(W_s + W_w)$ of the sediment sample; a useful conversion is

$$w = \frac{100 w_c}{100 - w_c} . \quad (9)$$

The third measure, particularly applicable to water-saturated sediments, is the void ratio, e , which is the ratio of the volume of void space, V_v , to the volume of solid particles, V_s , in a given sediment mass (ASCE), or

$$e = \frac{V_v}{V_s} . \quad (10)$$

Void ratio is determined in the laboratory from

$$e = \frac{G_s \gamma_w V}{W_s} - 1 . \quad (11)$$

where γ_w is the unit weight of water.

In Appendix B tables, void ratio also is recomputed at 100 percent saturation from the equation

$$e_{sat.} = \frac{G_s w}{100} . \quad (12)$$

Porosity, n , is the ratio in percentage of the volume of voids in a given mass, V_v , to the total volume of the sediment mass, V (ASCE), or

$$n = \frac{V_v}{V} \times 100 . \quad (13)$$

In this report, porosity was computed from the measured void ratio using the relationship

$$n = \frac{e}{1+e} \times 100. \quad (14)$$

This ratio is little affected by minor numerical differences in the degree of saturation. At 100 percent saturation, water content is related to the volumetric weight or porosity (in percent) by

$$w = \frac{n}{(100 - n) G_s} \times 100. \quad (15)$$

The percent or degree of saturation, S , is computed from

$$S = \frac{W_w}{\gamma_w \left(V - \frac{W_s}{G_s \gamma_w} \right)} \quad (16)$$

where $V - W_s / (G_s \gamma_w)$ is the volume of voids, V_v .

In Appendix B tables, saturation occasionally is shown exceeding 100 percent by a plus sign. This impossibility results from analytical errors.

It should be readily apparent that in order for values of water content to be significant the percent saturation must be stated. All too often marine geologists have assumed that water loss from cored samples is low or nil. As shown by Keller and others (1961), certain methods of sealing plastic core liners are inadequate to prevent water loss. Furthermore, even if the degree of saturation of the in-place sediment is close to, or at 100 percent, when the external hydrostatic pressure is removed, gas may be released from the water and expand the sample (Terzaghi, 1955, p. 560). If percent saturation were determined at the time water content was measured and published together with water content values, there would be no need for assumption or uncertainty by others in the use of the data.

As an expression of saturated water content, the use of void ratio, which has a constant denominator and a variable numerator, is technically preferable to porosity where both denominator and numerator are variables. Although void ratio is a more sensitive measure at high water contents, porosity is related to other parameters in this paper so that values can be compared directly to results obtained by other geologists.

It is a well known fact that water content in marine sediments may vary with depth of burial; an inverse relationship is most common. It is less well known that the length of the core sample measured affects this relationship to some extent; as the sample size increases, variations in water content may be reduced or entirely concealed. An experiment to investigate the effect of sample length in core G 5 is described by Richards and Keller (1962). They concluded that within a 10 cm (4 in) sample length of relatively homogeneous sediment, variations of water content were less than ± 4 percent from the 10 cm value when sand layers of small thickness were absent. Actual variations in the upper 215 cm of core G 5 are shown in Figure 9.

Results -- The least water content measured was 50.7 percent porosity in core F 6, and the maximum 85.7 percent in core G 3. Surface porosities ranged between 56.0 percent, core C 16, and 86.5 percent, core G 2 (Table 3); the latter value was computed from equations 12 and 14 with an assumed particle specific gravity of 2.73. Average surface porosities by area are given in Table 3; they range from 71.6 percent in Area B to 85.5 percent in Area G.

Porosity in general is inversely related to depth in all cores, except those from Area F; cores from Area H and D 1p show only a very slight decrease of porosity with increasing depth. The porosity profile in core F 6 is variable with depth. In the remaining Area F cores, the porosity profile decreases down to an intermediate depth and then increases to the bottom of the core. At an unknown greater depth, an inverse relation presumably again is established. The reason for the change appears to be related to the decrease in the percentage of the clay-size fraction at mid-depth and the resulting increase in particle median diameter.

Relation of porosity to most other parameters is considered elsewhere in this report. Porosity also is directly related to percentage of the clay-size fraction (Fig. 10).

Discussion -- The fine-grained fraction in marine sediments usually is predominantly composed of minerals, particularly the platy clay minerals and/or skeletons of micro-organisms. An inverse relation of mineral particle size to surface area is well known; however, that skeletal remains of micro-organisms, particularly diatoms, have large surface areas is somewhat less well known. Electron photomicrographs of siliceous diatom shells by Helmcke (1951) and Helmcke and Krieger (1951, 1952) show that the surface area of diatoms is enormous. In a clay-mineral investigation of selected Area C samples, J. C. Hathaway (report in preparation) determined the amount of skeletal remains of diatoms, coccoliths, and other micro-organisms by electron microscopy of the fine silt- and clay-size fraction. He found that the high water contents of these samples correlated with large concentrations of skeletal remains. In samples possessing essentially identical clay mineralogy, water content appears more closely related to

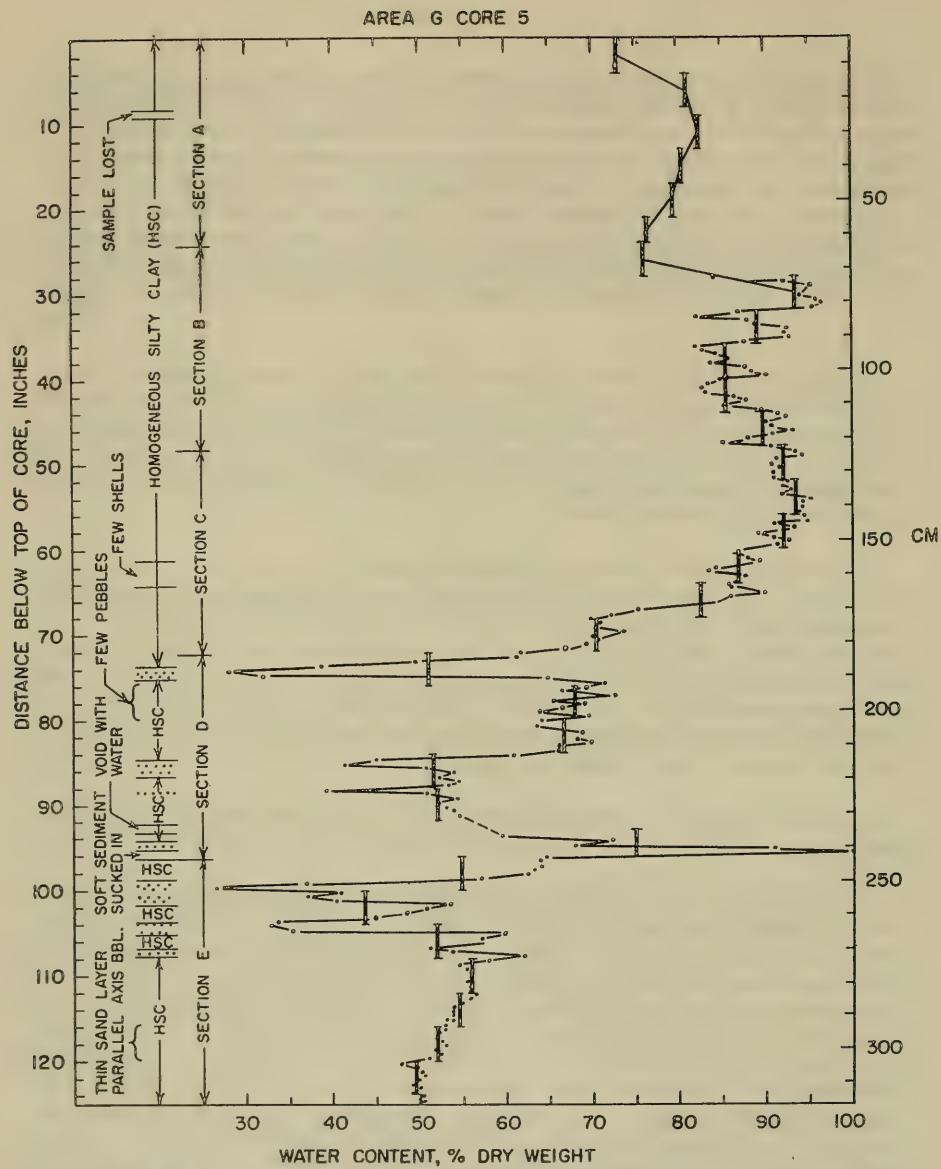


FIGURE 9. RELATION OF DEPTH IN CORE TO WATER CONTENT FOR CLOSE INTERVAL SAMPLING OF PISTON CORE G 5. (EACH DOT REPRESENTS ONE SAMPLE 0.5 INCHES LONG. AFTER RICHARDS AND KELLER (1962))

TABLE 3. SUMMARY OF SURFACE WATER CONTENT

Core	Sample (cm)	Water Content (% dry wt)	Porosity (%)	Porosity Area Average ¹ (%)	Void Ratio ² (100% sat)	Clay-size Fraction ³ (%)
A 23	0-5	125.42	78.4		3.500	--
A 31	0-5	116.10	77.0		3.246	43
A 33	0-5	135.07	79.2	78.2	3.793	53
B 83	0-5	84.13	70.8		2.354	47
B 85	0-5	95.03	73.0		2.657	50
B 87	0-5	83.79	70.9	71.6	2.359	47
C 16	0-5	41.6	56.0		1.152	34
C 18	0-5	64.31	65.2		1.804	26
C 19	0-5	161.69	82.0		4.488	33
C 20	0-5	173.57	83.1	71.8	4.836	35
D 1g	0-5	107.77	75.5		3.076	26
D 2	0-5	91.13	72.1	73.8	2.553	35
D 1p	11.5-23	87.01	70.7		2.398	ca20*
E 46	0-5	119.91	76.5		3.281	40*
E 47	0-5	113.46	75.8		3.093	52*
E 48	0-5	128.81	77.9	76.7	3.513	45*
F 6	0-11.5	48.67	57.2 ⁴		1.334	30*
F 10	0-5	113.25	75.5		3.060	47*
F 11	0-10	111.24	75.4		3.096	48*
F 12	0-5	140.54	79.5		3.851	46*
F 13	0-6.5	127.29	--		--	--
F 14	8-13.5	116.37	75.0		3.039	48*

¹Excluding values not including surface.²Values with only 3 significant figures are computed from assumed values of specific gravity of solid particles.³Based on 0-15 cm average unless asterisk indicated, in which event see the appropriate table in Appendix B.⁴Not included in Area F average.

TABLE 3. SUMMARY OF SURFACE WATER CONTENT (Cont'd)

Core	Sample (cm)	Water Content (% dry wt)	Porosity (%)	Porosity		Void Ratio ² (100% sat)	Clay-size Fraction ³ (%)
				Area Average ¹ (%)	Average ¹ (%)		
F 15	0-5.5	121.94	77.3			3.339	50*
F 16	0-5	156.52	81.0	77.7		4.298	48*
G 2	0-10	232.28	86.5			6.33	59*
G 3	0-10	235.22	86.4			6.363	59*
G 4	0-10	226.30	86.3			6.25	58*
G 5	0-10	73.08	--			--	--
G 6	0-10	236.90	86.4			6.35	55*
G 8	0-10	206.70	84.7			5.56	55*
G 9	0-10	202.20	84.7			5.54	51*
G 10	0-10	184.00	83.6			5.04	51*
G 11	0-10	136.30	--	85.5		--	--
H 12	30.5-35.5	116.84	76.9			3.307	59*
H 13	16.5-21.5	127.06	77.8			3.528	ca64*

the quantity of free water in the interstices of micro-organism skeletal remains than with free interstitial water associated with platy clay minerals.

Practically all mass physical properties are related to the amount of interstitial water in a sediment. Although water content is very easy to determine in the laboratory, there are remarkably few published measurements of sediments collected from depths greater than 132 m (72 fms), which corresponds to the average depth of the continental shelf edge (Shepard, 1948, p. 143). The degree of saturation apparently has not been determined on previous measurements of water content. This means that all earlier data should be questioned, although many samples reported in the literature may have been protected adequately against desiccation prior to test.

An example of the effect of a small amount of desiccation is shown in Area A through C cores. These cores were less well protected from drying before testing than those collected subsequently, which shows by measurements of less than 100 percent saturation in the tables of Appendix B. Saturations greater than 95 percent in soil mechanics laboratories usually are considered to represent 100 percent, the difference being due to analytical errors (C. M. Yeomans, personal communication). Nevertheless, when protective measures were better developed it is significant that the measured percentage of saturation rarely was less than 98 percent.

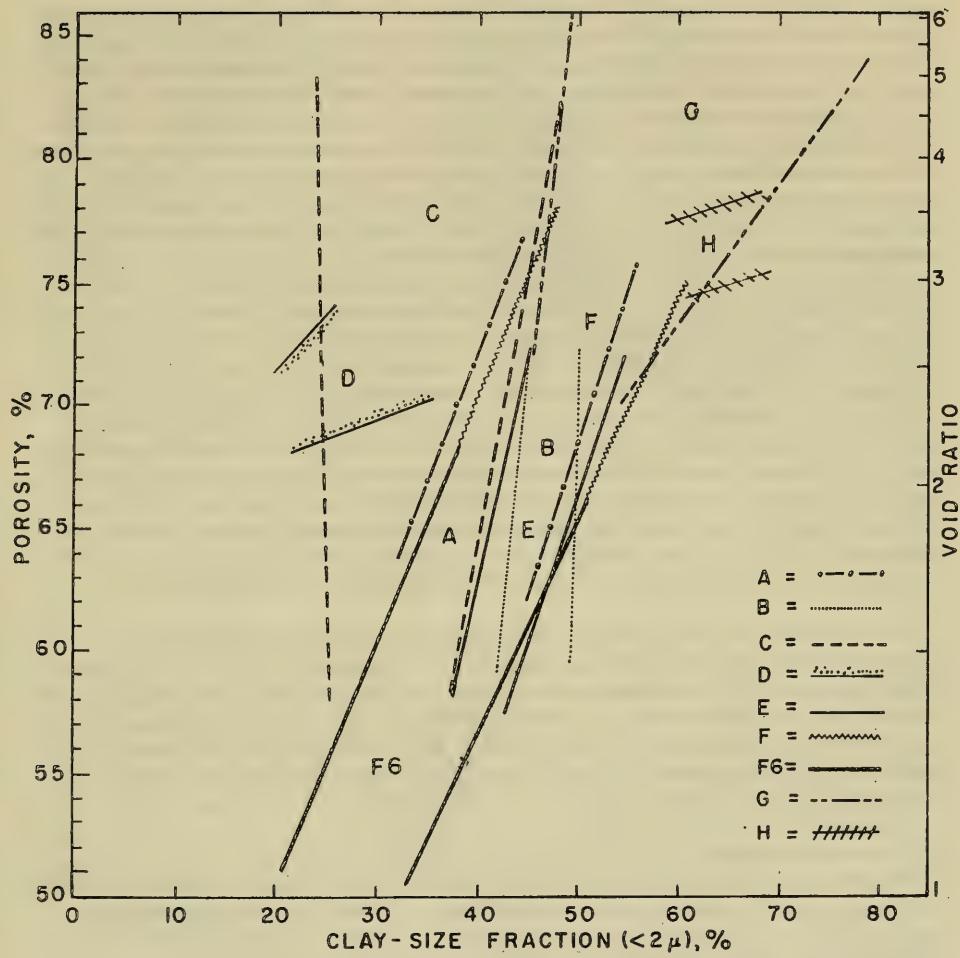


FIGURE 10. RELATION OF POROSITY TO CLAY-SIZE FRACTION. (SAMPLE VALUES FALL WITHIN THE LIMIT LINES FOR EACH AREA SHOWN)

Surficial porosities are of particular interest to investigators in sedimentation and engineering. An early study of nearshore Atlantic Ocean "muds" resulted in a range of water contents (porosity?) of 40 to 90 percent (Shaw, 1915). Terzaghi (1925c, p. 912) states that the volume of voids may be 98 percent of the total volume in clays. More recently, Emery (1960, p. 258) reported a maximum submarine sediment water content of 670 percent, corresponding to a porosity of 94.6 percent⁴; Correns (1937, p. 158) measured a maximum surficial water content of 86.6 percent wet weight, or a porosity of 94.6 percent⁴, in an equatorial Atlantic pelagic clay; and Arrhenius (1952, p. 79 and his appendix plate 2.55B-2.55) illustrates a maximum surficial salinity of 105×10^3 , corresponding to a porosity of 91.4 percent⁴, in the East Pacific eupelagic area. Some examples of the more usual range of fine-grained ($Md/\phi > 5$) surficial porosities in sediments from water depths greater than 400 m are: an average of 86 percent off Southern California (Emery, 1960, p. 258), 35 to 84 percent in the Pacific Ocean (Arrhenius, 1952, p. 79), 60 to 86 percent in the Pacific and Arctic Oceans (Shumway, 1960, p. 458-463), 59 to 86 percent in the Gulf of Mexico (Trask, 1953, p. 103, 120), 46 to 71 percent in the North Atlantic Ocean (Sutton and others, 1957, p. 796), and, as previously mentioned, 56 to 86 percent in this investigation. Studies of shallow-water marine sediments by Moore (1931), van Andel (1954), Shepard and Moore (1955), and Füchtbauer and Reineck (Engelhardt, 1960) show a similar porosity upper limit of about 86 percent. It is apparent that approximately 86 percent appears to represent the usual maximum porosity in fine-grained submarine sediments, although exceptional values may be higher. The observation that the average porosity of a clay at the time of deposition is about 50 percent (Yoder, 1955, p. 506) is not corroborated.

Shepard and Moore (1955, p. 1580) related the deposition rate in Gulf of Mexico sedimentary environments to the slope of a straight line representing average values of water content related to the percentage of the clay-size fraction. Their data indicated that the steepness of the slope was inversely related to the rate of deposition. A similar relation was found by Seibold (1956, p. 465-467) for sediments from other areas. The application of this hypothesis to the sediments investigated by the writer is equally satisfactory⁵:

⁴Emery's porosity values computed from equations 12 and 14, assuming a specific gravity of 2.65; Correns' porosity values from equations 8, 12, and 14, assuming a specific gravity of 2.7; and Arrhenius' porosities from his equation $W = 3.75 - 24$, equations 12 and 14, and an assumed specific gravity of 2.7.

⁵The following analysis admittedly is subjective. Nevertheless, the calculated relative rates cited were arrived at before Figure 10 was prepared, and the corresponding agreement later was found to be good.

Particle-by-particle, deep-sea deposition of pelagic clay, Area H, results in the slowest rate of deposition, and this area shows the least slope of a straight-line relationship between porosity and the clay-size fraction (Fig. 10). Each area in this figure is represented by two lines marking limits of plotted values. Reference is made in the following discussion to an imaginary line, which is not shown in Figure 10, located equidistant between the limit lines for each area. Area D, in the vicinity of the Blake Plateau, is in a region of slow deposition, which is shown by the presence of manganese nodules in the surficial layer of some cores and in dredge hauls collected by the Hydrographic Office. A moderate amount of pelagic deposition is indicated by the texture and mineralogy of Area C cores, and the resulting relative rate probably was fairly rapid. Area G is close to land, but swept by currents, and the expected rate of deposition is moderate. All other areas, A, B, E, and F, have similar depositional environments on the continental slope. With decreasing distance from land the relative rate of deposition should increase; this results in the sequence: F - E - B and A. However, the amount of sediment contributed from land influences the sequence and a more probable one, from slow to fast, is: E - F - B and A. The calculated relative deposition rate from these, and other less important considerations, is (relatively slow to fast): H - D - F, F 6, and G (about the same) - E - A, B, and C (about the same). The observed sequence from Figure 10 is (relatively slow to fast): H - D - F, F 6, and G - A - E - C - B. Differences between the two sequences are not considered significant.

F. PLASTICITY AND THE ATTERBERG LIMITS

Determination of limits -- Measurement of the Atterberg liquid limit, LL, was standardized three decades ago by use of a mechanical liquid limit machine designed by Casagrande (1932a). Liquid limit is arbitrarily defined by the ASTM (1958, p. 1132) as the water content at which two halves of a sediment cake will flow together for a distance of 1.25 cm (0.5 in) along the bottom of a groove separating the two halves when the cup containing the cake is dropped 25 times for a distance of 1 cm at the rate of two drops per second. An ASTM machine with a hard rubber base was used for all tests, together with an ASTM grooving tool. The plastic limit, PL, test briefly consists of measuring the lowest water content at which the sediment sample can be rolled into threads 3 mm (one-eighth in) in diameter without them breaking into pieces (ASTM, 1958, p. 1137).

Casagrande (1932a, p. 130; 1948, p. 922) reported that oven-drying fine-grained samples, as prescribed by ASTM designations D 423-54T (LL) and D 424-54T (PL), radically affects the limits of organic sediment and less markedly the limits of inorganic sediment; limits generally are higher for non-dried material. This relationship has been confirmed by Selmer-Olsen (1953) and Rosenqvist (1955, p. 72) for marine clays of normal salt content, although an opposite effect was found by Rosenqvist when clay

sensitivities were greater than 8. Samples were not dried prior to testing on limit tests at BUDOCKS and the Hydrographic Office, following recommendations by Casagrande (1948, p. 922) and a recommended British test method (Norman, 1959). One other difference in test procedure from that prescribed by the ASTM is that the limits were determined from the entire size fraction rather than from only that portion finer than 1.25ϕ (0.42 mm).

Dawson (1960) has shown that different operators may obtain slightly different results in the limit tests, despite test standardization. Furthermore, the type of material the base of the liquid limit machine is made of affects the measurement. Differences between British and American machines recently were summarized by Norman (1958). These and other problems in determining Atterberg limits are discussed by Bauer (1960).

Dr. Martin (1961, written communication) kindly informed me that the Atterberg limits of certain sediments are very sensitive to changes in interstitial water salt concentration, and that because the salt content is unknown in the samples investigated, the resulting data may be unreliable.

Results -- Measured values of liquid limit range from 25 (core F 6) to 109 percent dry weight (core D 1p). A more normal range is between 50 and 80 percent. Measured values of plastic limit range from 15 (core F 6) to 46 percent dry weight (core F 15). Most values lie between 20 and 30 percent. Emery (1960, p. 260) has reported that in cores tested at the University of Southern California the limits reflect changes in water content; cores with large variation in water content gave smaller variation for liquid limit and smallest variation for plastic limit. In general, this relationship was found in the cores tested.

The plasticity index, PI (LL-PL), affords a quantitative measurement of the plastic characteristics of a completely remolded sediment sample by defining the range of water content in which the sediment is plastic. Previously, it was mentioned that the A-line of the plasticity chart is an empirical boundary separating organic and inorganic clays, the former located below the line and the latter above. Considering only inorganic clays, those having liquid limits greater than 50 percent are highly plastic; the majority of samples tested are in this category (Fig. 4). Inorganic clays with liquid limits between 20 and 50 percent have low or medium plasticity: core F 6 and certain samples from Area C and E cores. Terzaghi and Peck (1948, p. 35) place the division between inorganic clays of low and medium plasticity at a liquid limit of 30 percent. Using this classification, only the 4 samples from core F 6 having water contents less than 40 percent have low plasticity. Burmister (1960, p. 98) considers the overall plasticity of clay sediments with plasticity indices greater than 40 to be very high.

Discussion -- Atterberg limits were determined on a number of cores collected from the continental borderland area off Southern California by Emery and his associates (Emery and Rittenberg, 1952, p. 765; Emery and Terry, 1956, p. 276-277; and Emery, 1960, p. 260-261). Reported values of water content in percent dry weight always were higher than liquid limits in the surficial sediments, although the reverse often occurred at depths greater than several feet. Emery (1960, p. 260) concluded that tops of the cores, where the water content is greater than the liquid limit, are liquid although they may not be mobile. With respect to this statement, I wish to emphasize that such sediments are "liquid" only in the remolded condition. In their undisturbed, in-place condition they may possess considerable structural strength, relative to their remolded strength; as stated by Terzaghi (1955, p. 563): "the strength of the sediment in situ at a water content equal to the liquid limit can amount to several hundred grams per square centimeter." At water contents about equal to the liquid limit, found at some distance below the top of the cores tested in the Hydrographic Office program, measured cohesion ranged from about 34 g/cm^2 , core A 23, to 234 g/cm^2 , core B 83⁶. With respect to the quantitative distinction between solid and liquid, the reader is referred to a discussion by Reiner (1958, p. 465-467, 542).

It is noteworthy that the only instance where the surface 0 to 5 cm water content was less than the liquid limit is in core C 16, where surface desiccation following core collection is shown by a measured 90.5 percent saturation (Appendix B).

An oft-repeated statement is that at the time of sedimentation water content approximates liquid limit (for example, Terzaghi, 1927, p. 41; Jones, 1944, p. 145; Skempton and Bishop, 1954, p. 433). On the other hand, Hough (1944, p. 1185) reports that water content is well above liquid limit in St. Lawrence River clay. Results of Emery and his associates and this paper show that the surficial sediments, often down to depths of several meters, possess water contents appreciably higher than the liquid limit. Occasionally, the liquid limit is exceeded by more than 80 percentage points (Emery, 1960, Fig. 211; this paper, core C 20). Not realizing the magnitude of this difference may lead to meaningless conclusions; for example, natural water content of a sediment a few percent higher than the liquid limit constitutes evidence that little desiccation has occurred between the time the core was collected and the time tested (Sykes, 1960, p. 49).

⁶These values are appreciably greater than cohesion at the liquid limit reported by Skempton and Bishop (1950, p. 99).

Other relationships derived from the Atterberg limits are the liquidity index⁷ (Terzaghi, 1936), B, which relates the water content to the limits and is defined as

$$B = \frac{w - PL}{PI} \times 100 \quad (17)$$

and colloidal activity (Skempton, 1953a, 1953b), a_c , which is defined by equation 21. The liquidity index denotes the ratio of excess natural water content above the plastic limit to the plasticity index (Capper and Cassie, 1960, p. 57). At a liquidity index of unity, or 100 percent when expressed as a percentage as recommended by the ASCE, the water content equals the liquid limit. Terzaghi (1955, p. 563) notes that although the liquidity index is close to 100 percent in the surficial layer of a normally consolidated⁸ clay deposit, it is always greater than 200 percent in a sediment formed on the bottom of a vessel filled with a clay suspension--an under-consolidated deposit. On page 566 of his paper, however, Terzaghi mentions that marine clays in their original state have liquidity indices of about one hundred percent. The surface samples of the cores examined possess liquidity indices of approximately 200 percent. Appreciably higher liquidity indices are found in several cores. A surface layer liquidity index greater than 1,200 percent, as a result of very low plasticity index, was found in the two calcareous gravity cores from Area D. The consolidation history of the cores will be discussed in a paper being prepared, as was previously mentioned.

⁷The liquidity index was computed for each sample having a measured water content. In most instances, the plastic limit and the plasticity index were usually averaged over several samples rather than determined on each sample because of small variability in the limits. Liquidity indices will be somewhat less than shown in Appendix B tables in the few instances where a marked decrease in water content occurs over the interval measured for liquid limit.

⁸A sediment deposit that has never been subjected to an effective pressure greater than the existing overburden pressure and one that is also completely consolidated by the existing overburden is normally consolidated (ASCE).

G. SHEAR STRENGTH⁹

Introduction -- Compressive strength and laboratory vane shear test analytical procedure and depth related to strength previously was described and discussed (part one). In brief, shear strength, s , is defined by the relation

$$s = c + \bar{\sigma} \tan \phi \quad (18)$$

where c is the apparent cohesion, $\bar{\sigma}$ is the effective stress normal to the shear plane (total stress minus pore pressure), and ϕ is the angle of shearing resistance. Fine-grained, saturated sediments stressed without change in water content behave with respect to applied stress as if they were purely cohesive materials having an angle of shearing resistance equal to zero ($\phi = 0$). In this special instance $s = c$. Compressive strength, p_c , is related to the cohesion or shear strength by

$$c = \frac{p_c}{2}. \quad (19)$$

The compressive strength test also is known as the U (for unconfined) test. Laboratory vane shear tests give results directly in shear strength.

Cohesion -- Values of cohesion in the samples tested range from 4.2 to 234 g/cm². Most cores have minimum cohesions near the top and maximum values usually at some depth other than the bottom. Table 4 summarizes surface or near surface cohesions. An average of the fifteen 0 to 5 cm cohesion measurements of predominantly terrigenous sediments is 19.8 g/cm². The stronger calcareous Area D sediments have an average of 43.2 g/cm² (2 measurements) in the 0 to 5 cm interval.

Cohesion generally shows a direct relationship to wet unit weight and an inverse relationship to water content or porosity. Relation to median diameter, percentage of the sand- or clay-size fraction, and plasticity index is variable, sometimes direct and sometimes inverse.

⁹An extremely important book by the American Society of Civil Engineers (1961) on its research conference on shear strength of cohesive sediments appeared after this report was written. Unfortunately, it has not been possible to incorporate recent results reported in this paper, except for a few instances, because other commitments upon my time precluded an opportunity to assimilate its contents.

TABLE 4. SUMMARY OF SURFACE AND NEAR SURFACE COHESION

Core	Sample (cm)	Cohesion ¹ (g/cm ²)	Cohesion Area Average ² (g/cm ²)
A 23	0-5	4.2	
A 31	5-10	9.1	
A 33	0-5	7.7	6.0
B 83	0-5	23.9	
B 85	0-5	20.4	
B 87	0-5	26.0	23.4
C 16	0-5	37.3	
C 18	0-5	46.4	
C 19	0-5	6.3	30.0
C 20	5-10	11.2	
D 1g	0-5	55.5	
D 2	0-5	30.9	43.2
D 1p	11.5-23	77.3	
E 46	0-5	22.0*	
E 47	0-5	37.2*	
E 48	0-5	13.1*	24.1
F 6	0-11.5	29.5	
F 10	0-5	28.8	
F 11	0-10	28.8	
F 12	0-5	7.7	
F 13	11.5-16.5	33.8	
F 14	8-13.5	37.3	
F 15	0-5.5	21.1	
F 16	0-5	5.3*	20.2

¹Values from compressive strength tests and equation 20 unless followed by an asterisk, which denotes vane shear test.

²Excluding values not including the surface.

TABLE 4. SUMMARY OF SURFACE AND NEAR SURFACE COHESION (Cont'd)

Core	Sample (cm)	Cohesion ¹ (g/cm ²)	Cohesion Area Average ² (g/cm ²)
G 3	10-20	14.4*	
G 8	20-30	25.2*	
G 9	20-30	14.3*	
G 10	20-30	17.1*	
H 13	16.5-21.5	71.7*	

The logarithm of cohesion related to porosity, with an eye-fitted straight line representing the suggested average, is shown for each area (Fig. 11). Scatter of values about the straight line varies from small in Area B to large in Areas E and G.

It was stated previously that the slopes of lines representing averages in each area, shown on a porosity-percentage of clay-size graph, denote relative rates of deposition in the sequence (from slow to rapid): H--D--F and F 6--G--A--E--C--B (Fig. 10). A similar correlation between relative rates of deposition and the slope of lines representing averages appears on a logarithm of cohesion-porosity graph (Fig. 12). The sequential relationship shown in Figure 12 is identical to that of Figure 10, except that the position of Area B and core F 6 in the sequence is reversed in Figure 12.

Since there is a clear relationship between porosity and percentage of the clay-size fraction, a similar relation between the latter and cohesion was expected but not found (Fig. 13). The variable relationship of cohesion to the percentage of the clay-size fraction in each area is shown graphically in this figure.

For most engineering purposes, cohesion or shear strength in fine-grained, cohesive sediments from a given area can be estimated with reasonable accuracy from a knowledge of the water content (compare Figs. 11 and 12) and slope of the line representing the average relationship of porosity to cohesion. Measurement of water content by neutron moderation¹⁰ and measurement of wet unit weight by gamma-ray

¹⁰The number of moderated or slow neutrons detected per unit time is a measure of the concentration of hydrogen atoms that are contained in molecules of free water, assuming absence of organic material. A slow neutron count thus becomes a measure of the sediment water content.

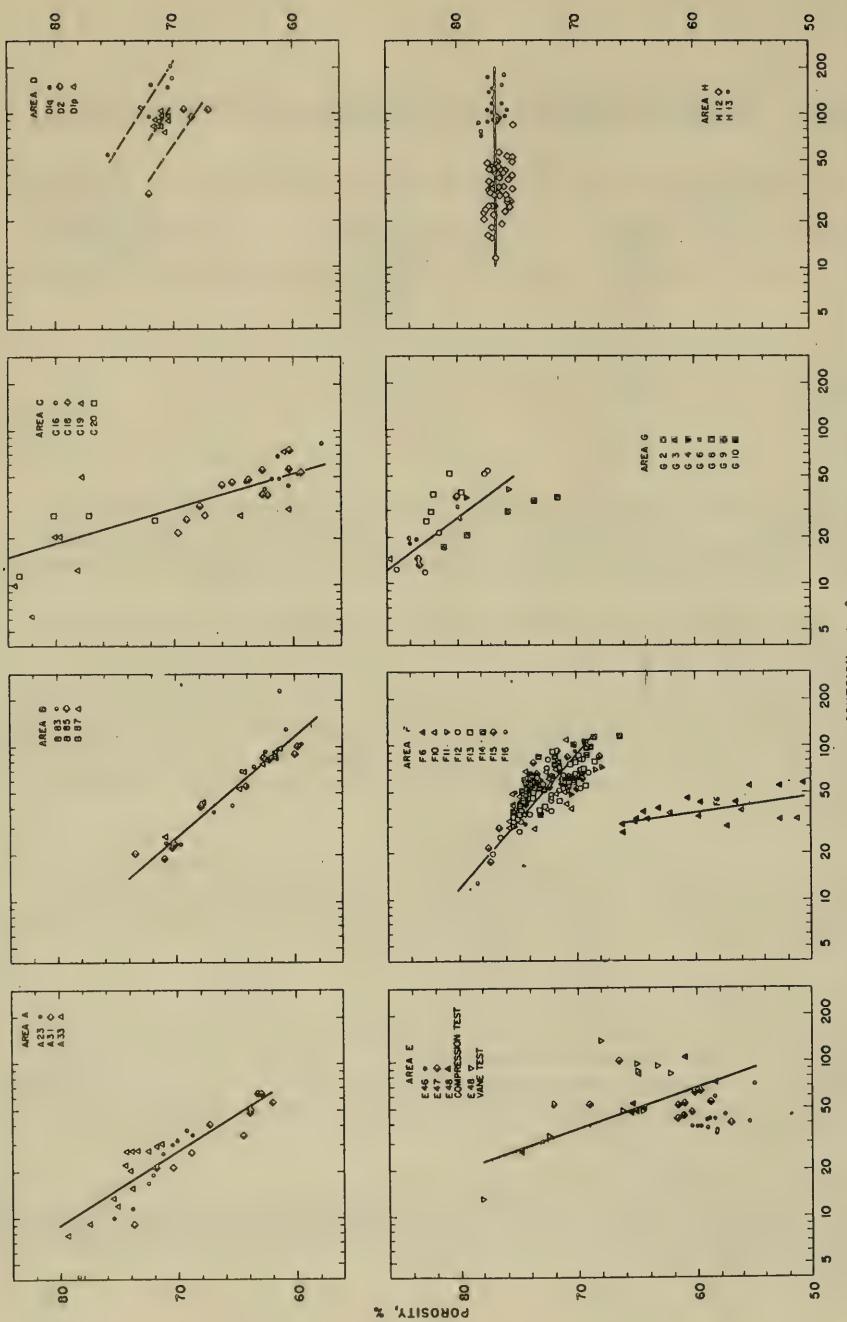


FIGURE 11. RELATION OF POROSITY TO LOGARITHM OF COHESION BY AREA. THE STRAIGHT CORRELATION LINE SHOWN FOR EACH AREA IS EYE FITTED TO THE DATA

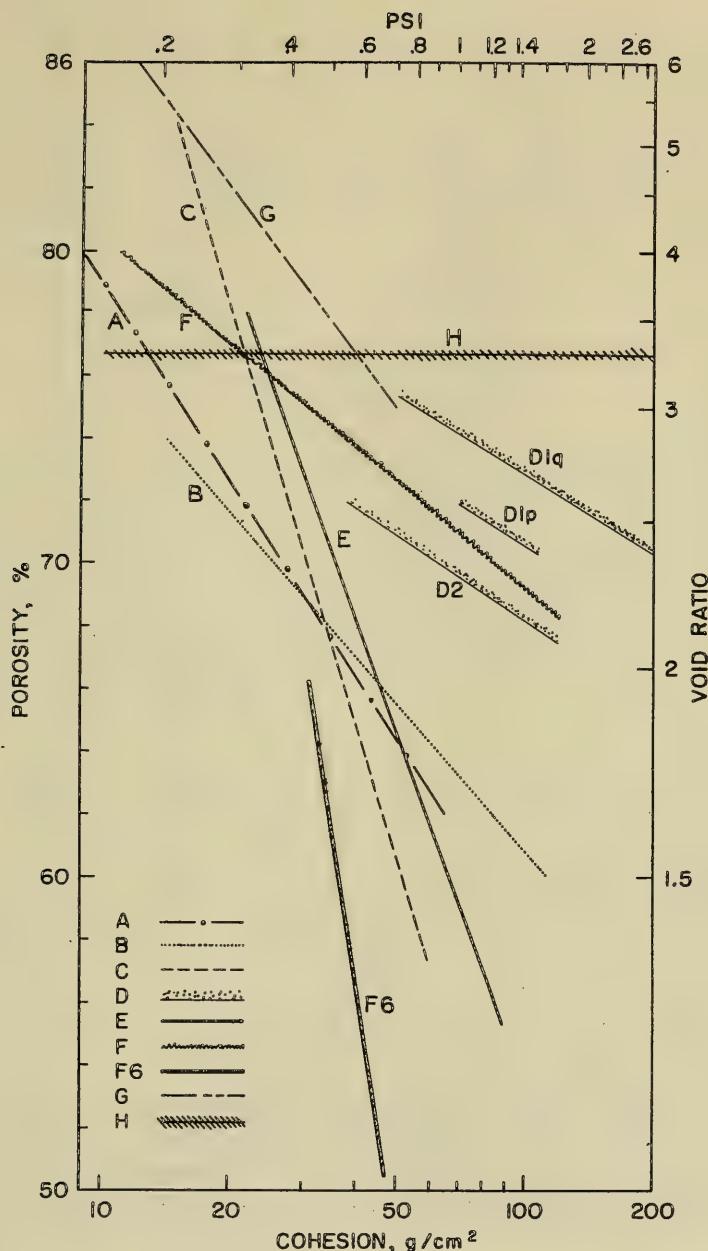


FIGURE 12. RELATION OF POROSITY TO LOGARITHM OF COHESION BY AREA AVERAGE. CORRELATION LINES FROM FIGURE 11 ARE SHOWN SUPERIMPOSED TO INDICATE DIFFERENT SLOPES

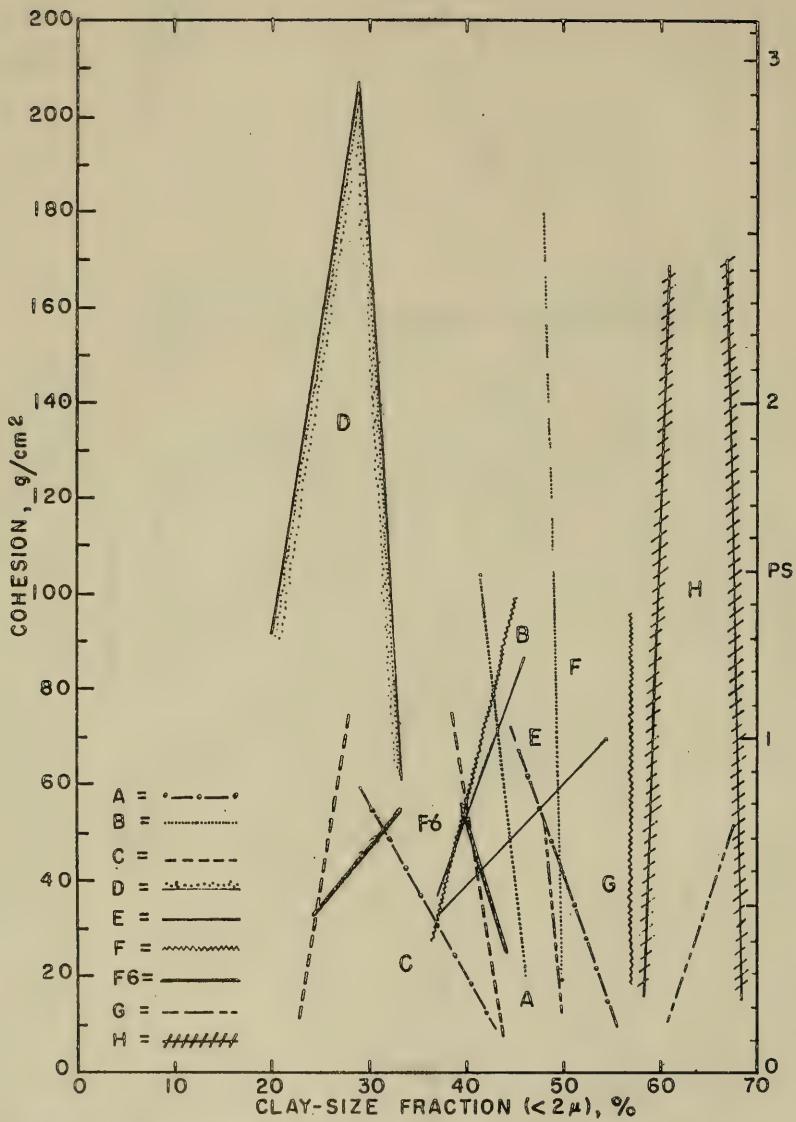


FIGURE 13. RELATION OF COHESION TO CLAY-SIZE FRACTION. SAMPLE VALUES FALL WITHIN THE LIMIT LINES FOR EACH AREA SHOWN

methods is now routine (see, for example, Kuranz, 1960; Meigh and Skipp, 1960); recently density determinations have been made on in-place marine sediments (Caldwell, 1960, p. 27-28). An extension of the method would be to estimate shear strength directly on suitable in-place or laboratory samples with a neutron probe calibrated for the water content-strength relationship of the particular sediments under investigation.

Sensitivity -- Defined by Terzaghi (1944, p. 613) as

$$S_t = \frac{\text{undisturbed strength}}{\text{remolded strength}}, \quad (20)$$

sensitivity, S_t , is a measure of the loss of strength when the structural strength of sediment is destroyed by remolding; the higher the sensitivity the greater the loss of strength in the remolded condition. A classification of sensitivity proposed by Skempton and Northey (1952, p. 31), modified by Rosenvqvist (1953, p. 195), and with a percentage loss of strength added by me, is given in Table 5. Samples range from slightly insensitive to very sensitive with a few values of medium quick sensitivity in Area H cores not shown in Figure 14. Porosity possibly may be directly related to sensitivity, as shown by the dashed line between two limiting lines (Fig. 14), although the scatter of values is very large.

TABLE 5. CLASSIFICATION OF FINE-GRAINED SEDIMENT SENSITIVITY

Sensitivity	Description	Percentage of "Undisturbed" Strength Lost in Remolded State
ca 1	Insensitive	0
1 - 2	Slightly insensitive	0 to 50
2 - 4	Medium sensitive	50 to 75
4 - 8	Very sensitive	75 to 87.5
8 - 16	Slightly quick	87.5 to 93.8
16 - 32	Medium quick	93.8 to 96.9
32 - 64	Very quick	96.9 to 98.4
> 64	Extra quick	> 98.4

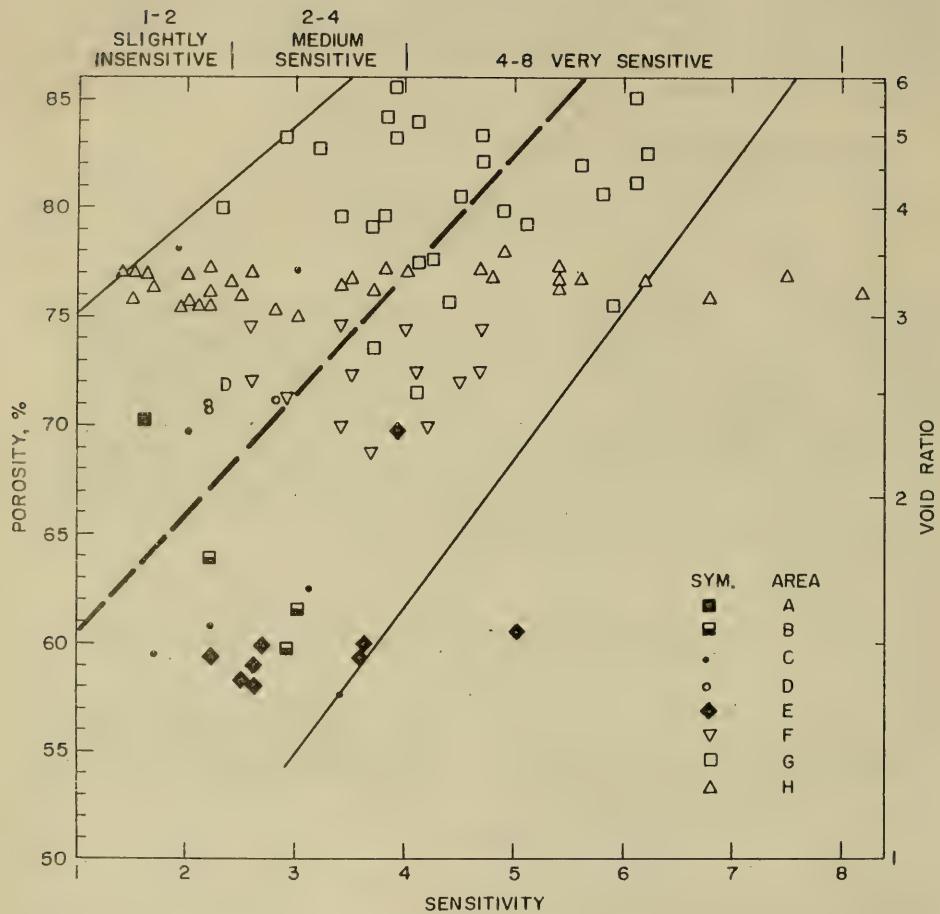


FIGURE 14. RELATION OF POROSITY TO SENSITIVITY. THE EYE-FITTED DASHED LINE REPRESENTS A SUGGESTED CORRELATION BETWEEN THE TWO LINES DENOTING GENERALIZED LIMITS

Skempton (1953b, p. 61) reported that the liquidity index, defined by equation 17, may be used as a measure of sensitivity. The available data (Fig. 15) indicate that this relationship may be valid if each area is considered separately and correlation lines are forced through the origin. Two lines are shown, however, for Area C samples. The two C 16 and bottom C 19 samples plot with those from Area F, while the C 18 and C 20 samples have lower sensitivities and plot separately. The middle C 19 sample ($LI = 400$) has a high plasticity index that is anomalous compared to the other Area C samples shown in Figure 15. If correlation lines are not forced through the origin, a clear relationship between the logarithm of sensitivity and liquidity index does not exist.

Discussion -- Hvorslev (1936; 1937, p. 148) established that the cohesion of saturated sediments was dependent on the water content and independent of the stress history of the sample. Rutledge (1947, p. 21, 67) showed that the logarithm of cohesion was a straight- or slightly curved-line function of water content. Trask and Rolston (1950) confirmed this relationship in sediments of San Francisco Bay. Bjerrum (1951, p. 217; 1954a, p. 60, 89, 92) reported the same relationship to be unique for normally consolidated clays. This paper gives further confirmation in deep-sea sediments.

It is difficult to assess the relative importance of subordinate factors affecting strength, such as grain size and clay type. In laboratory experiments relating clay content and grain size to strength, Trask and Close (1958) and Trask (1959) found: (1) at a given water content, strength increased from kaolin and illite (very slightly stronger than kaolin) to montmorillonite; (2) at a given water content and sand-clay ratio, strength increased as the sand grain size decreased above 2.9ϕ (below 135μ); and (3) at a given water content and grain size, strength of all clays increased as the ratio of clay to sand increased. Comparison of clay mineralogy (see Table 6) in the 15- to 30-cm (6 to 12 in) samples of cores B 87 and C 18 suggest the reverse of condition (1) above; however, two samples are of little significance. The other two conditions cannot be compared because of the variability of parameters held constant by Trask.

Sediment structure, thixotropy, and salt content of interstitial water also affect strength and sensitivity. Until very recently it was uncertain whether the structure of cohesive sediment was principally honeycomb (Terzaghi, 1925a, p. 10-11; 1925c, p. 914; Casagrande, 1932b, p. 180-186) or cardhouse (Goldschmidt, 1926--cited by Rosenqvist; Lambe, 1953, p. 38; and others). Rosenqvist (1958, 1960) published stereo photographs, obtained with an electron microscope, of fresh water clay and remolded and undisturbed marine clay that appear to confirm the Goldschmidt-Lambe cardhouse structure hypothesis in undisturbed marine clays. The photographs show a very open mineral arrangement with principal contact between corners and planes (Rosenqvist, 1960, p. 6).

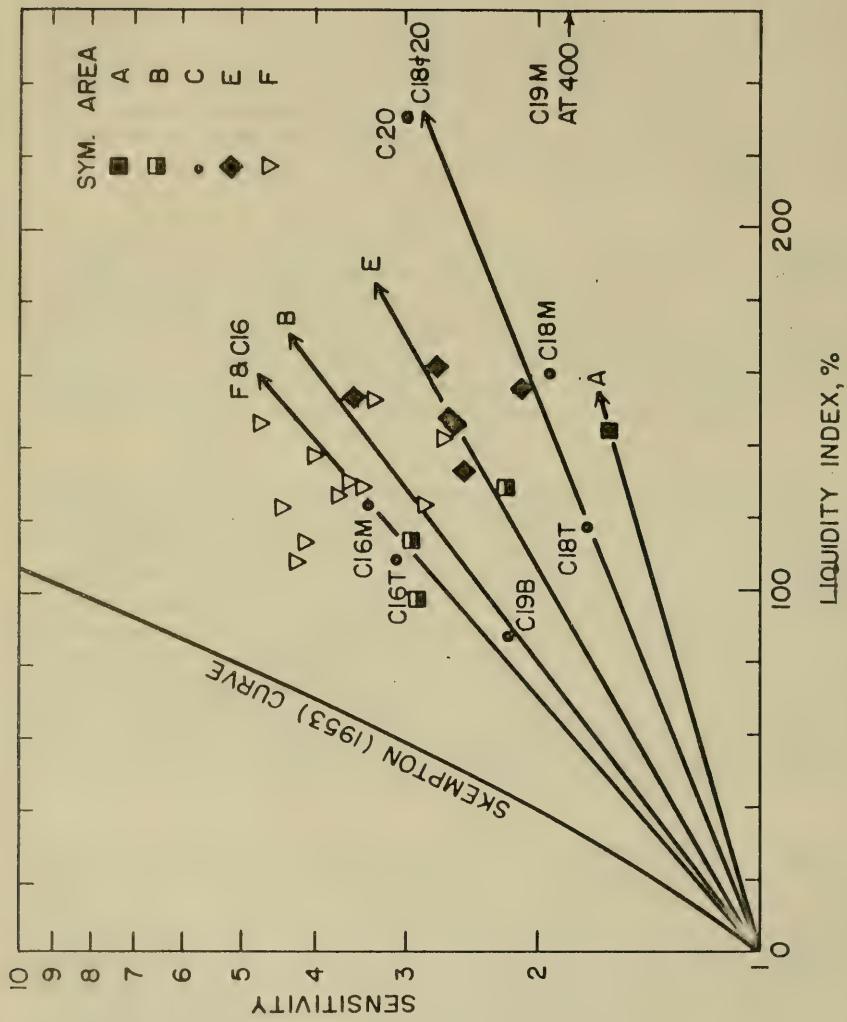


FIGURE 15. RELATION OF LOGARITHM OF SENSITIVITY TO LIQUIDITY INDEX. THE CORRELATION LINES ARE FORCED THROUGH THE ORIGIN, SEE TEXT FOR DISCUSSION. (LETTERS B, M, AND T FOLLOWING SAMPLE NUMBERS DENOTE BOTTOM, MIDDLE, AND TOP OF CORE, RESPECTIVELY)

It was mentioned previously that Hathaway (report in preparation) demonstrated that the quantity of micro-organism skeletons was directly related to the water content in selected Area C samples. It is likely that this relation also is valid in other areas subject to pelagic deposition. Both skeletons of micro-organisms and platy clay minerals are characterized by very large surface areas; the former, however, probably contribute relatively little cohesion or plasticity to a sediment, while the latter has an opposite effect. An abundance of skeletal remains in fine-grained sediments influences the structural properties, in addition to the relation of increased interstitial water content to reduced cohesion. It appears reasonable to suppose that parallel rearrangement of cardhouse structure following disturbance will be inhibited by an abundance of microskeletal remains. Consequently, it also is likely that sensitivity will tend to be inversely related to the quantity of microskeletons.

Thixotropy is defined by the ASCE as the property of a material that enables it to stiffen in a relatively short time on standing, but upon agitation or manipulation to change to a very soft consistency or to a fluid of high viscosity, the process being completely reversible. Van der Waals forces and Coulombic forces are the principal interparticle forces affecting clay particles. Van der Waals forces normally cause attraction, but decrease with about the sixth power of the distance from the particles; Coulombic forces, decreasing with the square of the distance, are the electrostatic attraction between the positively charged edges and negatively charged faces of different particles and also the electrostatic repulsion between two edges or two faces of adjacent particles (Hvorslev, 1961, p. 170-171). A detailed discussion of these forces and their relation to cohesion is given by Lambe (1961). According to a recent hypothesis (Mitchell, 1960, p. 29-31), externally applied shearing energy in remolding causes the platy clay particles (previously in cardhouse structure) to be rearranged in a parallel structure leaving adsorbed water layers and ions in a high energy structure where the attractive forces are much greater than repulsive forces immediately after shearing stops. With time, thixotropic hardening produces structural rearrangement to a lower energy condition, and the attractive forces decrease. A new equilibrium results when water returns to a low energy structure, attractive and repulsive forces are equal, and clay minerals once again have a more or less cardhouse structure. Thixotropic strength regain may be inversely related to the abundance of microskeletons in clayey skeletons, because a large quantity of skeletal material will inhibit electrochemical forces tending to produce rearrangement of the clay minerals.

As stated in Appendix A, it is uncertain whether or not the salt content of pore water in the surface few meters of submarine sediments generally is constant or variable. Should the salt contents prove to be variable, and particularly if it should be inversely related to depth, investigations of salt leaching from marine clays reported by Rosenqvist (1946-published in English, 1953; 1955), Skempton and Northe (1952), Bjerrum (1954b), and Bjerrum and Rosenqvist (1956) may prove highly applicable to marine geological

studies. The principal conclusion reached by these investigators was that reduction of pore water salt content, or leaching, decreases the undisturbed shear strength of clay and increases the sensitivity; although, Skempton and Northeby (1952, p. 43) found a reduction of the remolded strength but not of the undisturbed strength. It is suggested that variability of submarine sediment sensitivity may be, at least in part, explainable by changes in pore water salt content. Measurement of interstitial water salinity is of importance, and it is to be regretted that so few measurements exist.

In conclusion, natural marine sediment, predominantly composed of mineralogenous matter, apparently has a cardhouse structure that will be rearranged into a parallel orientation if disturbed by sampling for instance. It is hypothesized that rearrangement may be directly proportional to the quantity of microskeletal remains in the fine-grained fraction. A corollary of the hypothesis is that at about the same water content sediments rich in microskeletons will tend to have lower sensitivities than those composed entirely of clay minerals. Following structural rearrangement, a regain of strength due to thixotropic hardening will occur with time. If the clay consists of an ideal, purely thixotropic plastic material, the strength regain will be complete. Skempton and Northeby (1952, p. 35, 38) found that most natural clays were not purely thixotropic materials. Furthermore, coarse-grained cohesive sediments, composed of sand and possibly containing less than 5 percent clay minerals, possessing thixotropy are mentioned by Mielenz and King (1955, p. 223). It is probable that most deep-sea sediments once disturbed likewise will not completely regain lost strength. The answer to the question how much of the original strength in slightly disturbed sediment cores will be regained over a specific time will have to wait until less disturbed samples than those at present are collected, or until it proves feasible to make in-place tests on the ocean floor.

H. MODULUS OF ELASTICITY

The modulus of elasticity is defined by the ASCE as the ratio of stress to strain for a material under given loading conditions; it is numerically equal to the slope of the tangent or the secant of a stress-strain curve. Values reported in Appendix B were determined from results of the compressive strength tests; they range from 0 to 870 g/cm² (0 to 12.4 psi).

This modulus sometimes is used in settlement computations where deformation occurs in accordance with Hooke's law (see, for instance, Skempton and Bjerrum, 1957, p. 169, who note that the modulus of elasticity--called Young's modulus--is sensitive to sampling disturbance, especially in normally consolidated clays). Further discussion of stress, strain, elasticity, and plasticity can be found in books on these subjects (for example, Westergaard, 1952) and need not be considered here.

I. MINERALOGY AND ACTIVITY

Procedure -- A few samples were investigated for clay mineralogy to examine the relationship between clay mineralogy, clay-size fraction, and plasticity index. X-ray diffraction, differential thermal analyses, and surface area studies were made by Messrs. E. B. Kinter and S. Diamond of the Physical Research Division, Bureau of Public Roads. Their X-ray analytical procedure is described by Kinter and Diamond (1956). In these studies, a General Electric XRD-3D direct-recording X-ray diffraction machine was operated as follows: 40 KV at 20 ma, nickel-filtered CuK α radiation, scans at 2° per minute, and 1° beam and 0.2° detector slit widths. Clay mineral surface areas were determined using the method of Diamond and Kinter (1958) from glycerol retention measurements (Kinter and Diamond, 1958).

In the Hydrographic Office, the grain-size fraction coarser than 4 ϕ was cursorily examined under a binocular microscope by laboratory personnel to obtain an estimation of the percentage of skeletal material and mineral grains.

Mineralogy -- Results of the greater than 9 ϕ fraction are summarized in Table 6. Montmorillonite percentage is based on surface area measurements (Areas A and B composite sample: external area 62 m²/g, internal area 173 m²/g) and are believed by Kinter to be accurate within a few percent. Other percentages in this table are based on an "educated guess" by Kinter and Diamond, following similar reasoning to that made by Johns and others (1954). These estimates may be in error \pm 40 percent from the stated value, although Kinter believes \pm 5 percent is more reasonable. According to J. C. Hathaway (1961, written communication), who also has studied the mineralogy of certain Area C core samples, the mixed layered montmorillonite-mica contains about 30 percent mica layers. Percentage of quartz and calcite (\pm 5 percentage points) in the whole sample, plasticity index, and computed activity are also presented in Table 6.

Results of an estimation of carbonate content by hydrochloric acid treatment and microscope estimations of the coarse fraction are summarized in Table 7 for comparison with the data presented in Table 6. It is evident that calcareous skeletal material and shells account for the majority of material in the coarse fraction from Areas A and B, and mineral grains are more abundant than carbonate in Area C.

Activity -- More than a decade ago Skempton (1948) established a relation between the ratio of the liquid limit and the clay fraction greater than 9 ϕ (less than 2 μ), which he called activity. By activity is meant the increased surface activity of the clay fraction, for example, the increased ion exchange capacity and adsorption of water with decreasing grain size. Clays were classified as: inactive clay, $a_c < 0.75$, normal clay, $a_c = 0.75$ to 1.25, and active clay, $a_c > 1.25$. This ratio was redefined later (Skempton, 1953a, p. 42-43; 1953b, p. 58) in terms of the direct linear relationship

TABLE 6. SUMMARY OF THE GREATER THAN 9 PHI FRACTION AND WHOLE SAMPLE MINERALOGICAL ANALYSIS

Sample	% Sample > 9 ¹	% Composition of > 9 ² Fraction 2,4	X-ray Diffraction Angle ⁵ of Whole Sample	Plasticity Index ³	Activity $(\frac{P_1}{clay\ fraction})$
A 31, 6-12 in	46	mica kaolinite	40 20	29 36	9 10
A 31, 30-36 in	40	mixed layered montmorillonite-mica	20	26	8
A 33, 6-12 in	55	calcite	5 to 10	24	11
A 33, 30-36 in	51	quartz, feldspar (?), and chlorite	10 to 15	15 19	47
B 87, 6-12 in	46	mixed layered montmorillonite-mica	50	—	0.9
B 87, 24-30 in	49	mica kaolinite chlorite (high Fe) quartz and feldspar	20 10 10	36 — —	27 32 26
C 18, 6-12 in	25				0.6 0.65 1.0
C 20, 6-12 in	28				39
					1.4

¹Determined at the Hydrographic Office.²Determined at the Bureau of Public Roads.³Determined at the Bureau of Yards and Docks.⁴Area A and B samples: percentage determined from X-ray analysis on each sample, augmented by differential thermal analysis (DTA), and measurement of montmorillonite surface area by glycerol retention on a composite of all samples except B 87, 24-30, which was inadvertently omitted. Area C samples: whole sample treated with acetic acid to remove calcite, hydrogen peroxide to remove organic matter, and Jackson's dithionite method to remove free iron oxide prior to X-ray diffraction analysis; DTA and glycerol treatment were not made.⁵Percentages determined from comparison with standard dilution sample of Ottawa sand for quartz and limestone for calcite. Aragonite was not found in the diffraction.

TABLE 7. SUMMARY OF COARSE-FRACTION ANALYSIS

Sample	% Sample < 4φ ¹	% Composition of < 4φ Fraction		Microscopic Estimation ¹ Tests, etc., 3	Mineral Grains ⁴
		Carbonate Removed by HCl Treatment (< 4.25φ) ²	minerals carbonate		
A 31, 6-12 in	5	--		80	20
A 31, 30-36 in	9	minerals	60	85	15
A 33, 6-12 in	2	carbonate	40		
A 33, 30-36 in	5	--	--	90	10
B 87, 6-12 in	7	carbonate minerals	95	90	10
B 87, 24-30 in	3	minerals	05	100	0
C 18, 6-12 in	18	--	--	95	05
C 20, 6-12 in	17	quartz and feldspar miscellaneous	90 10	20 35	80 65

¹Determined at the Hydrographic Office.²Determined at the Bureau of Public Roads.³Skeletal material and shell fragments, including Foraminifera, echinoid spines, and sponge spicules identified by me in the A 31 samples.⁴Predominantly quartz, feldspar, and mica.

between the plasticity index, instead of the liquid limit, and the clay fraction, where

$$a_c = \frac{PI}{\text{clay fraction percentage} < 2\mu} \quad (21)$$

The same activity classification was retained. Skempton (1953b, p 57) showed that the activities of a number of samples plot about a straight line that extrapolates back to the origin of a plasticity index-clay fraction graph, or activity chart.

The relationship between surface activity of colloidal particles, clay minerals, and quartz and calcite found by Skempton is shown in Figure 16 together with data from the samples investigated. Agreement of data is reasonably good. The higher montmorillonite content of the two samples from Area C is reflected in higher activities. Although the clay mineralogy of Area A and B samples was found nearly identical, the latter are less plastic and, as a result, have lower activities. Greater scatter about an average line (not drawn in Fig. 17) for samples from each area results when all available samples are plotted on an activity chart (Fig. 17). In this Figure, Hathaway (1961, written communication) is of the opinion that the term "illite" should be replaced with "mixed layered mica-montmorillonite," having a probable range of activity from about kaolinite to between Ca- and Na-montmorillonite. Yoder and Eugster (1955, p. 252-254)¹¹ discuss problems with the term "illite."

A further subdivision of Skempton's classification is indicated in Figure 17 with additional lines at activities of 0.25 and 1.75. A tentative activity classification of: inactive < 0.25 , slightly active, 0.25 to 0.75; normal, 0.75 to 1.25; active, 1.25 to 1.75; and very active > 1.75 is suggested for sea-floor sediments. More data are needed, however, before it will be known whether or not these additional categories are significant elsewhere. Using this nomenclature, the very highly plastic Area C core samples are active. Most Area B, E, and all of the F 6 samples are slightly active. Area D samples are mostly inactive, except piston core D 1. This core is relatively homogeneous in composition and has a plasticity index of 81 and a 20 percent clay-size fraction, that results in the exceptionally high activity of 4.0, which is not plotted in Figure 17. All other samples, Area A, C, and F, have normal activity.

Elsewhere, Fisk and McClelland (1959, p. 1383) found that late Quaternary continental shelf clays off Louisiana have an activity of about 0.9 and hence are normally active.

¹¹This reference kindly was called to my attention by Dr. J. C. Hathaway.

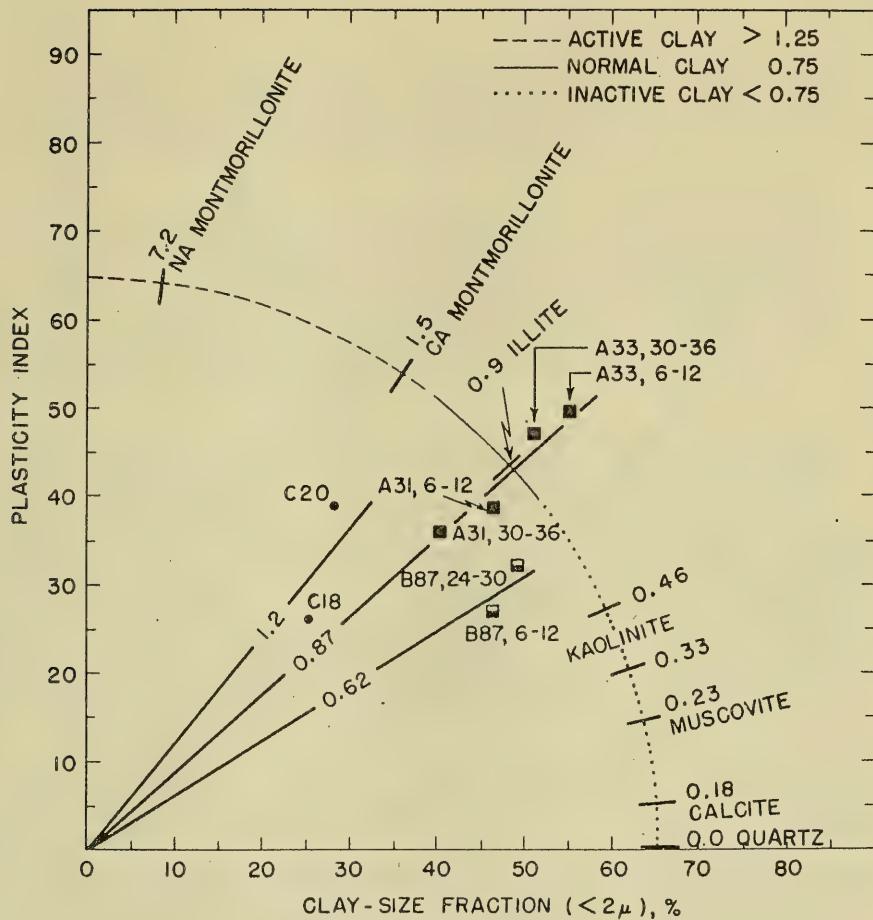


FIGURE 16. ACTIVITY CHART OF CORE SAMPLES WITH KNOWN CLAY-SIZE MINERALOGY. NUMBERS INSCRIBED ALONG THE CIRCLE REFER TO ACTIVITY. SEE TEXT FOR DISCUSSION

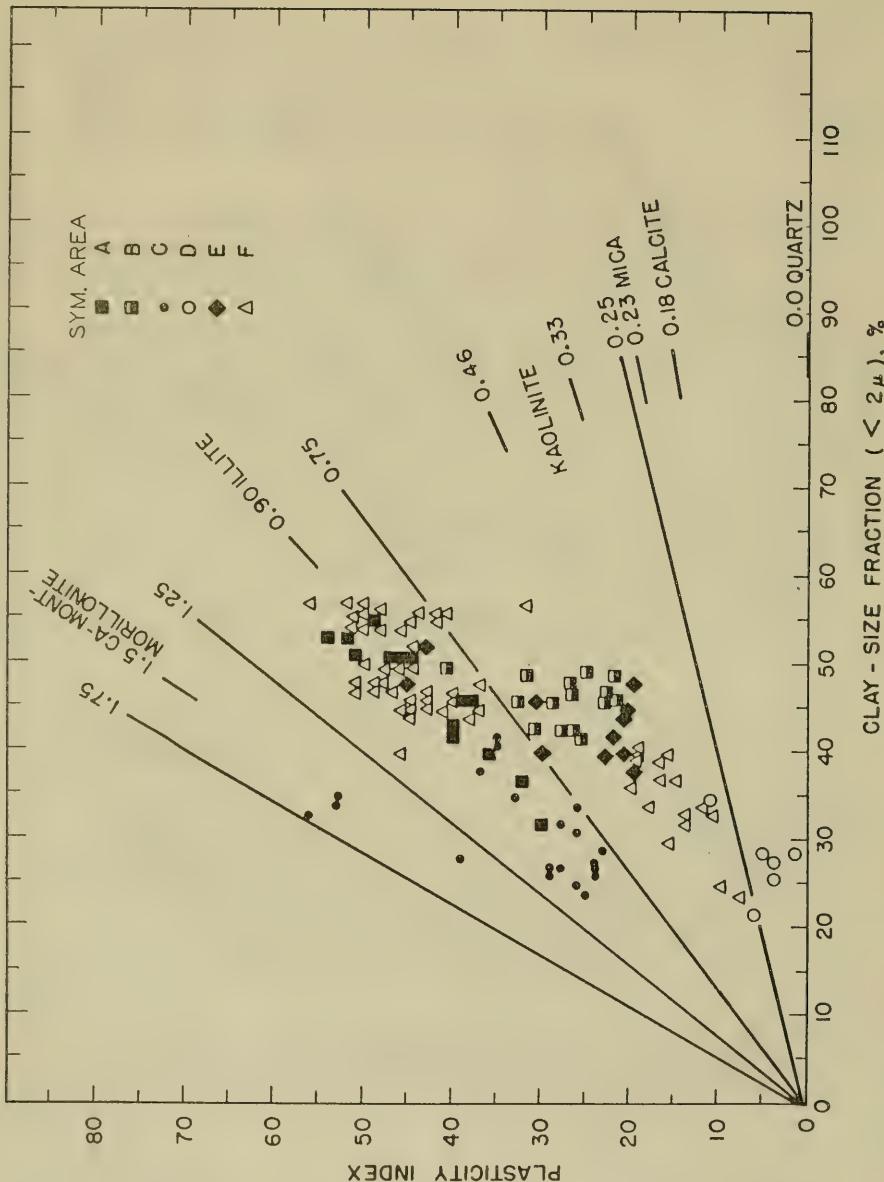


FIGURE 17. ACTIVITY CHART. NUMBERS REFER TO ACTIVITY. SEE TEXT FOR DISCUSSION

V. SUMMARY AND CONCLUSIONS

Measurements of mass physical properties were made in the laboratory on 35 gravity- and piston-type sediment cores, ranging in length from 30 to 511 cm, collected from ocean depths of 400 to 5120 m. Sample composition was predominantly silty clay- and clayey silt-size material, chiefly of terrigenous origin.

The M.I.T. grain-size scale was used in classifying sediments instead of the Wentworth scale because a silt and clay particle division at 9ϕ or 2μ appears more significant in mass studies. A plasticity chart is applicable to deep-sea sediments; its use, together with a triangular diagram, is recommended to marine geologists. Terrigenous inorganic sediments plot above and parallel to the empirical A-line on the plasticity chart. Mixtures of terrigenous and calcareous sediments either plot below the A-line or above it on a distinctly different axial slope from that of terrigenous inorganic sediments.

Grain-size was measured to 9ϕ and estimated to 10ϕ . Statistical measures other than median diameter were not applicable, because the size fraction finer than 10ϕ was greater than 25 percent in most samples. Median diameter of particles showed a variable relation with depth, in certain cores increasing and in others decreasing or fluctuating with depth. Void ratio was found to be directly related to median diameter for all 8 areas, although values scattered widely about the averages. When porosity and median diameter data from other investigations were added to that of the present one, the only clear relationship resulting was that low porosity sediments do not have small median diameters. It was demonstrated that the field below a curvilinear line extending from 7.5ϕ at 50 percent porosity to 10ϕ at 75 percent porosity, in an arithmetic plot of porosity related to median diameter, was devoid of values.

Corrections for salt content of interstitial water were not made in determining the specific gravity of solids, wet unit weight (corresponding to in-place bulk density), or measures of water content, because of the uncertainty of the magnitude of variations in submarine sediments. Unfortunately, measurements of the salinity of interstitial waters were not made. Specific gravity of solids for nearly 500 samples varied between 2.68 and 2.89, with an approximate average about 2.765. A first report is made of a tendency for specific gravity of solids to be directly related to wet unit weight and inversely related to porosity.

Sediment wet unit weight ranged from 1.23 to 1.86 g/cm³ and increased with increasing depth in most of the cores. Porosity was found to be inversely related to wet unit weight, with values corresponding to those previously cited by others. The different relationship of water content (porosity in water-saturated sediments) to wet unit weight reported by Ratcliffe (1960) is not corroborated.

It is strongly urged that if measures of water content of marine sediments are to be meaningful the following information must be concurrently published: (1) the drying temperature, (2) degree of temperature variation in the drying oven, (3) percentage of pore-space saturation, and (4) salt content. Regrettably, in the past, the latter three factors rarely have been stated. Percentage of saturation was determined each time a water content was measured, and it was found that all samples reported except one were effectively 100 percent saturated. The exception was a surface sample that had become desiccated between the time of collection and test.

Water content (porosity) generally decreases with increasing depth in the cores, although a number of exceptions were found. Porosity varied between 51 and 86 percent; surface (0 to about 5 cm) porosities averaged by area ranged from 72 to 86 percent. Measurements made by other investigators are compared to show that although the maximum reported porosity is about 95 percent the usual maximum in fine-grained surficial sediments is approximately 86 percent.

A relationship between deposition rates and correlation of water content related to percentage of the clay-size fraction was demonstrated by Shepard and Moore (1955), investigated by Seibold (1956), and further confirmed in this paper. Slowest depositional rates have the least axial slope, and fastest rates possess the greatest slope of correlation lines plotted on an arithmetic graph of porosity and percentage of clay-size material.

Measurements of the liquid limit and plastic limit showed an extreme range from 25 to 109 percent and 15 to 46 percent, respectively. A more normal range was 50 to 80 percent for liquid limit and 20 to 30 percent for plastic limit. Confirmation is given Emery's (1960) statement that the Atterberg limits reflect changes in marine sediment water content; the largest variation occurring in water content, less variation for liquid limit, and least for plastic limit.

Emery and his associates demonstrated that the water content in surficial submarine sediments always is greater than the liquid limit. His findings are confirmed by Sykes (1960) and this paper. In surficial sediments, the liquidity index commonly was found to be 200 percent or more, with a few values greater than 1,200 percent in calcareous sediments having very low plasticity indices.

It is emphasized that when the water content is greater than the liquid limit, sediment is "liquid" by definition only in the remolded condition. Sediment possesses considerable strength in an undisturbed (in-place) condition relative to the remolded strength. Even in the completely remolded state all samples tested showed measurable strength and hence strictly speaking cannot be considered liquid. It is generally recognized by workers in soil mechanics that remolded sediment at the liquid limit has a strength of a

few tens of g/cm², and that undisturbed sediment at the liquid limit has a strength about an order of magnitude greater.

A quantitative measure of the plastic characteristics of a completely remolded sediment is afforded by computation of the plasticity index, which defines the range of water content in which sediment is plastic. Most of the predominantly inorganic sediments of terrigenous origin and one core of calcareous clayey silt possessed high plasticity (values located above the A-line on the plasticity chart with the liquid limits greater than 50 percent).

Shear strength is expressed as cohesion because tests were made on water-saturated, fine-grained cohesive sediments without change in water content during the tests. Cohesion ranged from 4.2 to 234 g/cm². Minimum values usually occur at the surface and maximum values at some depth other than at the bottom of the cores. An average of surface, 0 to 5 cm, measurements is about 20 g/cm² in predominantly terrigenous sediments and about 40 g/cm² in calcareous sediments.

In a given sedimentary environment, wet unit weight generally was directly proportional to porosity and inversely related to cohesion. Median diameter, the sand- or clay-size fraction, and plasticity index sometimes showed direct and sometimes an inverse relation to cohesion.

Further confirmation is given the (usually straight-line) relationship between porosity and the logarithm of cohesion. Comparison of the different axial slopes on porosity-logarithm of cohesion plots of each of the 8 areas suggests almost the same relationship of relative deposition rates found in graphs of porosity as a function of the clay-size fraction, although the porosity-logarithm of cohesion slopes are negative. Cohesion was found to have a variable relationship to the clay-size fraction.

It is a well-known fact that the logarithm of cohesion is closely related to water content. This indicates that a simple means of rapidly making a large number of shear strength measurements in suitable laboratory samples, or in-place on the sea floor, would be by measurement of the water content using a neutron probe that has been calibrated for the water content-strength relationship of the particular sediments under investigation.

Measurements of sensitivity by compression and vane tests show that porosity may be directly related to sensitivity, although there is a very large scatter of values about the suggested average. The liquidity index has been considered by others to be a measure of sensitivity. This generally is confirmed in the samples tested if each area is considered separately and correlation lines are forced through the origin; otherwise there does not appear to be a clear correlation between these two parameters.

The Goldschmidt-Lambe hypothesis of cardhouse clay mineral structure in undisturbed marine sediments recently appears confirmed. Hathaway (report in preparation) demonstrated that high water contents correlate with large concentrations of skeletal remains of diatoms, coccoliths, and other micro-organisms. It is hypothesized that cardhouse structure will be modified by the presence of microskeletons; following structural disturbance it is likely that rearrangement of cardhouse structure to a parallel orientation of platy minerals will be inhibited by microskeletons. Consequently, it is suggested that sensitivity and thixotropic strength regain will tend to be inversely related to the quantity of microskeletons.

Complete thixotropic strength regain in deep-sea sediments following disturbance caused by sampling is considered unlikely.

It is suggested that variations in submarine core sensitivity may be related to changes in pore-water salt content, however, data presently are not available for evaluation of this idea.

Modulus of elasticity, determined from compressive strength tests, ranged from 0 to 870 g/cm².

A few clay-size ($> 9\text{\AA}$) samples from Areas A-C were examined for clay mineralogy. In Areas A and B, mica was more common than mixed-layered montmorillonite-mica (illite) or kaolinite; in Area C, mixed-layered montmorillonite-mica was more common than either mica or kaolinite.

Skempton (1953a, 1953b) showed that the plasticity index was a function of the clay-size fraction, and he designated the ratio of the two parameters activity, which was related to clay mineralogy. This relation has been confirmed by a number of investigators, including Fisk and McClelland (1959) for late Quaternary Louisiana continental shelf clays, and it appears valid for the few submarine sediments examined. The spread of the reported data suggests a further extension of Skempton's classification, which is considered tentative until more information from submarine sediments becomes available.

A general summary of the variation of the more important parameters with increasing distance below the top of each core is presented in Table 8. Although elsewhere distances or depths are given in centimeters, in this table depths are in inches to facilitate location of values in the plates and Appendix B. The extreme ranges of the more significant measured or computed parameters found in this investigation are summarized in Table 9 for ready reference.

TABLE 8. GENERALIZED SUMMARY OF PARAMETER VARIATION WITH INCREASING DEPTH IN CORES¹

Core	Length Tested (in.)	Particle Median Diameter (μ)	Sand-Size Material (%)	Clay-Size Material (%)	Specific Gravity of Solids	Wet Unit Weight (g/cm^3)	Plastic Limit		Liquid Limit	Plasticity Index	Water Content	Cohesion Profile (g/cm^2)	Notes
							n.d.	incr.					
A 23	30	n.d.	n.d.	n.d.	n.c.	n.c.	n.c.	incr.	n.c.	0.4	decr.	incr.	
A 31	41	decr. 18-30	higher 18-30	sl. - deer. 0-30	n.c.	n.c.	n.c.	incr.	lower 18-30	0.32	decr.	incr.	
A 33	36	n.c.	n.c.	n.c.	n.c.	n.c.	n.c.	incr.	0.18	0.32	n.c.	n.c.	
B 83	36	decr. 0-18	higher 24-30	sl. deer. 0-18	n.c.	n.c.	n.c.	incr.	0.18 + 18+	0.14	decr.	incr.	
B 85	30	decr.	n.c.	n.c.	sl. deer.	n.c.	n.c.	incr.	n.c.	0.18	decr.	decr.	
B 87	30	decr. 0-15	decr. 15+	sl. deer. 0-18	n.c.	n.c.	n.c.	incr.	0.18	0.18	decr.	n.c. 0-10	
C 16	30	n.c. 0-12	decr. 12+	higher 0-12	incr. 0-16	deer. 0-18	n.c.	decr.	0.18	0-12 + 12+	decr.	incr. 10+ decr. 0-22	
C 18	42	decr. 0-12	decr. 12-	n.c. 0-18	incr. 0-22	deer. 0-22	n.c.	decr.	12-24	higher 0-12	decr.	decr.	
C 19	30	decr. 0-18	higher 12-24	n.c.	decr. 12-	deer. 0-18	n.c.	decr.	12+	0-8	decr.	decr.	
C 20	18	decr.	sl. - incr. 12+	higher 0-6	sl. - incr. 0-12	deer. 0-12	n.c.	decr.	12+	0-14	decr.	decr.	
D 1g	16	sl. incr.	sl. lower 8-12	sl. lower 0-4	sl. - deer.	n.c.	n.c.	sl. incr.	0-8	higher 4-8	decr.	large incr.	
D 2	9	decr.	incr.	decr.	n.c.	n.c.	n.c.	decr.	0-6	lower 4-8	decr.	large incr., 0-6	
D 1p	180	n.d.	n.d.	n.d.	n.c.	n.c.	n.c.	variable	0-14	0-6	n.c.	small 6+ n.c.	

TABLE B. GENERALIZED SUMMARY OF PARAMETER VARIATION WITH INCREASING DEPTH IN CORES (Cont'd)

TABLE 8. GENERALIZED SUMMARY OF PARAMETER VARIATION WITH INCREASING DEPTH IN CORES¹ (Cont'd)

Core	Length Tested (in.)	Particle Median Diameter (phi)	Sand-Size Material (%)	Clay-Size Material (%)	Specific Gravity of Solids	Wet Unit Weight (g/cm ³)	Plastic Limit	Liquid Limit	Plasticity Index	Water Content	Cohesion Profile (g/cm ²)	Notes
G 4	68	n.c.	n.c.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*
G 5	28	sl. incr. 0-3 sl. deer. 13+	n.c.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*
G 6	59	sl. incr. 0-56	n.c.	higher 34+	sl. incr.	n.c. 8-17+ sl. incr. 17+	n.d.	n.d.	n.d.	n.d.	large deer. 1-3+ sl. incr. 1-3+	*
G 8	70	n.c.	n.c.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	large deer. 0-40 incr. 40-52+ deer. 52+	*
G 9	52	n.c.*	n.c.*	n.c.*	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*
G 10	64	n.c.* variable higher 16-40	n.c.* rel. n.c. n.c.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*
G 11	46	incr. 0-16 deer. 16-30 incr. 30+	n.c.	n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	*
H 12	201	n.d.	n.c.	n.c.	n.c.	n.d.	n.d.	n.d.	n.c.	n.c.	n.c.	*
H 13	37	n.d.	n.c.	n.c.	variable variable	rel. n.c.	n.d.	n.d.	n.d.	n.d.	n.d.	but variable large incr. 7-16 deer. 16-39 n.c. 37-53 incr. 39+

¹All measurements in inches from the top of the core. Where parameter variation with increasing depth is slight or does not occur, it is omitted.

Abbreviations: n.d. = no data, n.c. = little or no change, sl. = slight, rel. = relatively, deer. = decrease, incr. = increase, discontin. = discontinuous.

TABLE 9. SUMMARY OF MEASURED OR COMPUTED MINIMUM AND MAXIMUM PARAMETERS IN AREA A - H CORES

Parameter	Minimum	Maximum
Activity	0.06	1.7
Cohesion, "undisturbed," g/cm ²	4.2	234.1
Cohesion, remolded, g/cm ²	2.1	38.6
Liquid limit	25	109
Liquidity index, %	76	3274
Median diameter of particles, ϕ	5.1	>10
Modulus of elasticity, g/cm ²	0	870
Plastic limit	15	46
Plasticity index	1.6	81
Porosity, %	50.7	86.5
Sensitivity	1.6	25.9
Specific gravity of solids	2.68	2.89
Void ratio, 100% saturated	1.015	6.363
Water content, % dry weight	36.7	236.9
Wet unit weight, g/cm ³	1.23	1.86

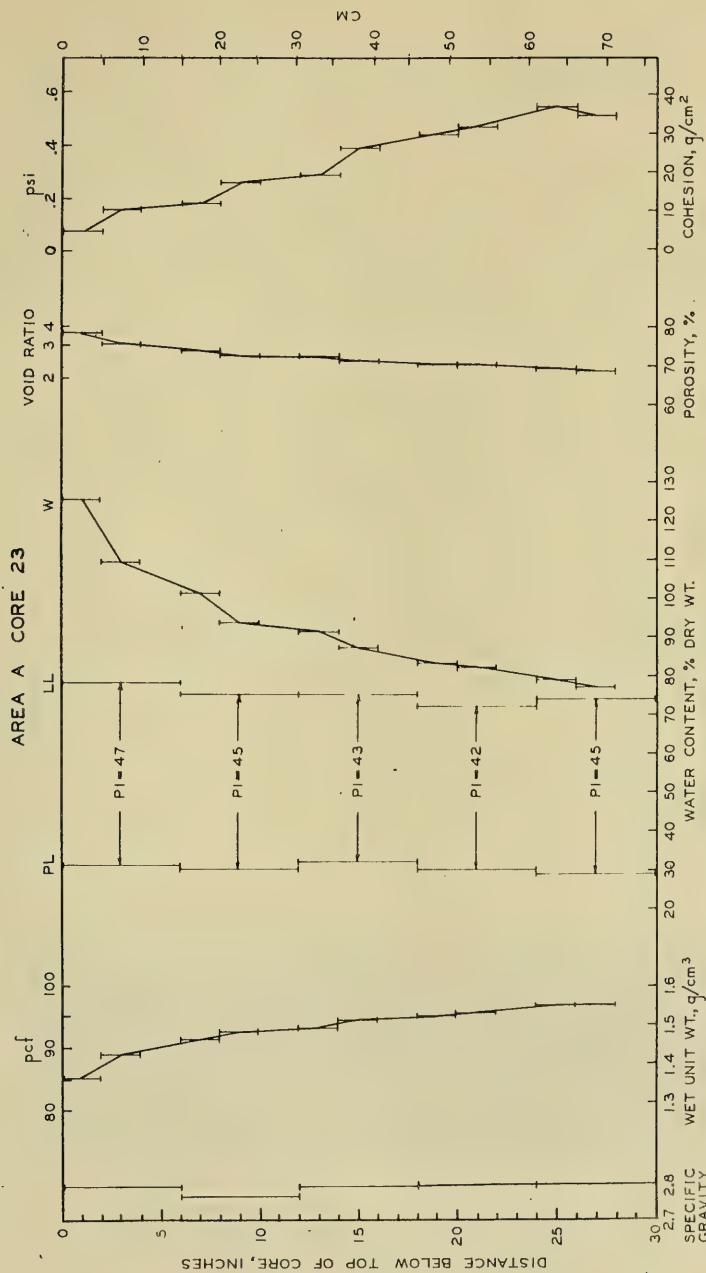


PLATE I. PARAMETERS VERSUS DEPTH FOR CORE A 23

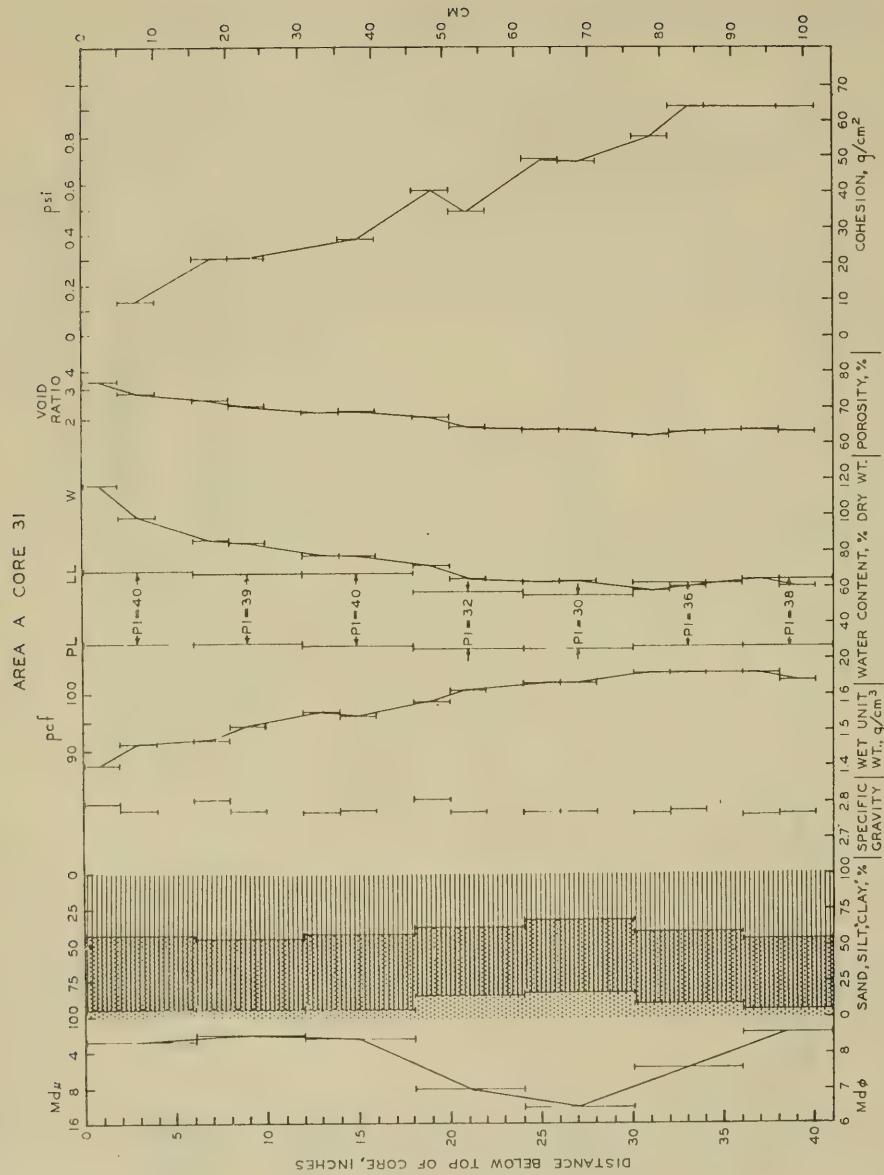
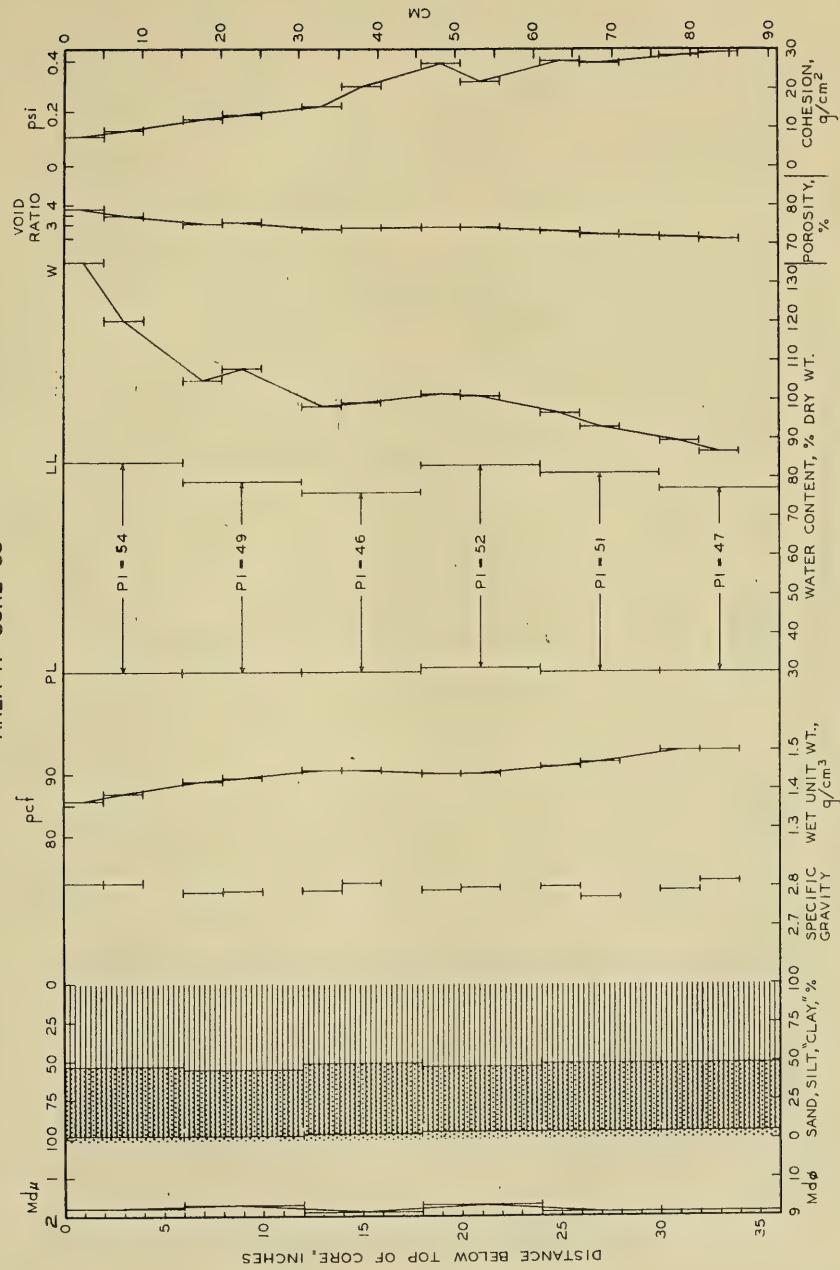


PLATE II. PARAMETERS VERSUS DEPTH FOR CORE A 31

AREA A CORE 33



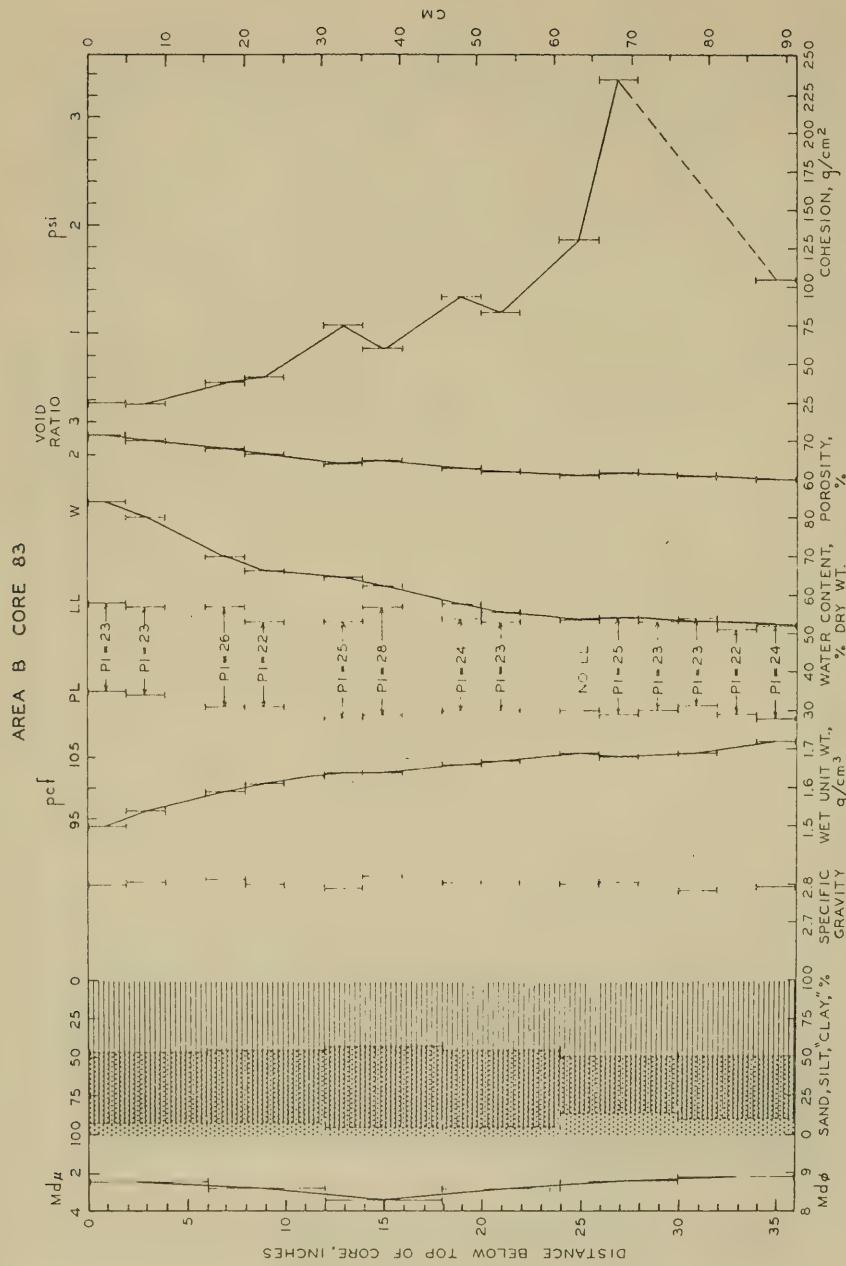


PLATE IV. PARAMETERS VERSUS DEPTH FOR CORE B 83

AREA B CORE 85

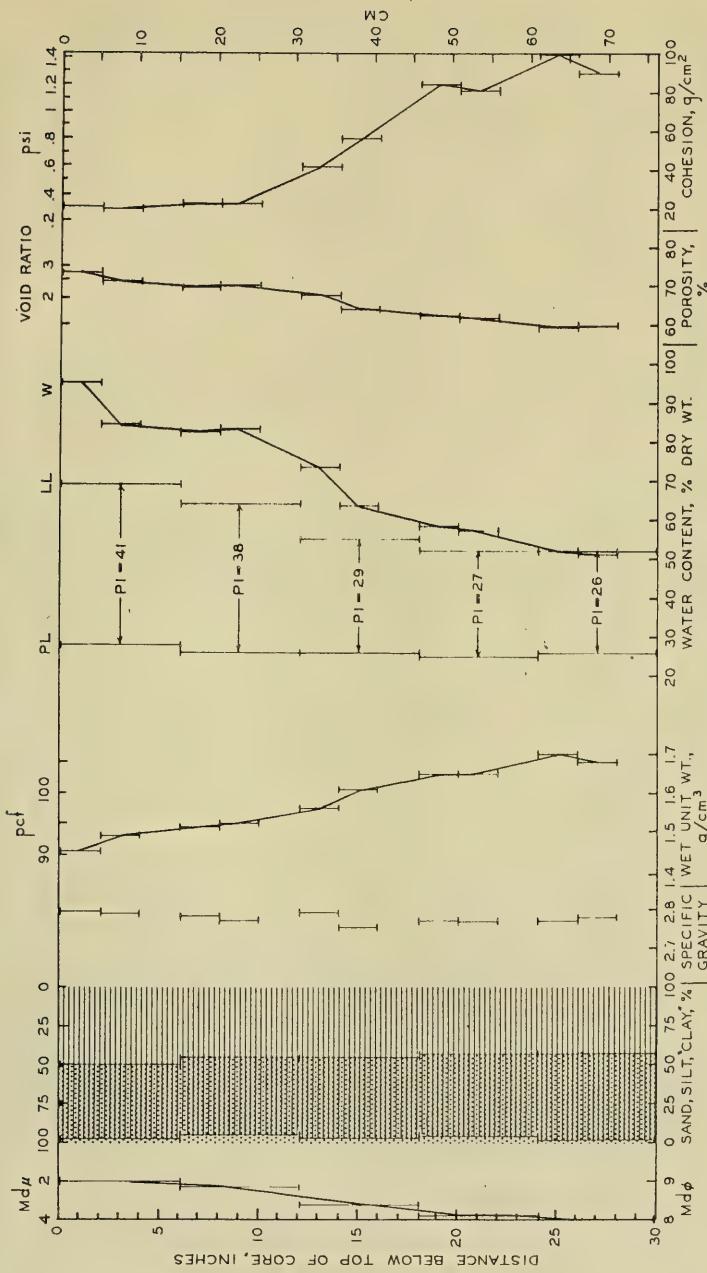


PLATE V. PARAMETERS VERSUS DEPTH FOR CORE 85

AREA B CORE 87

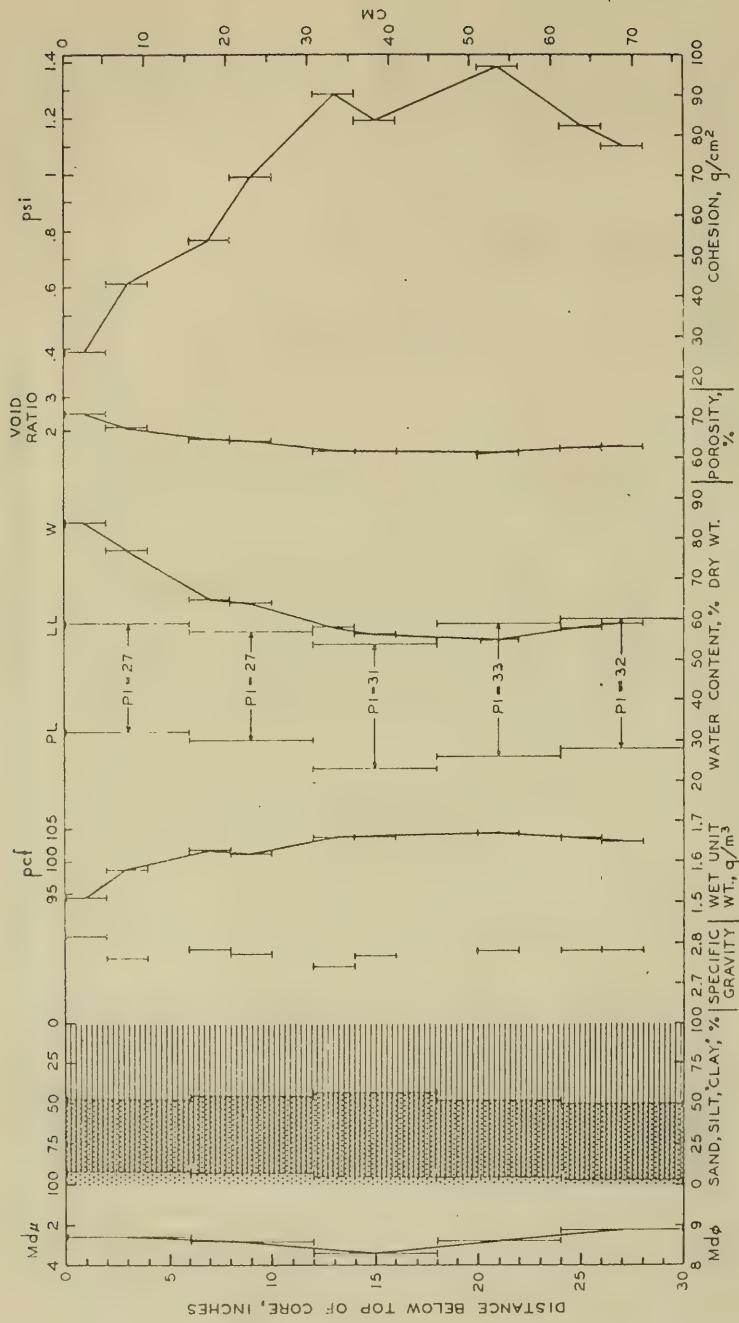


PLATE VI. PARAMETERS VERSUS DEPTH FOR CORE B 87

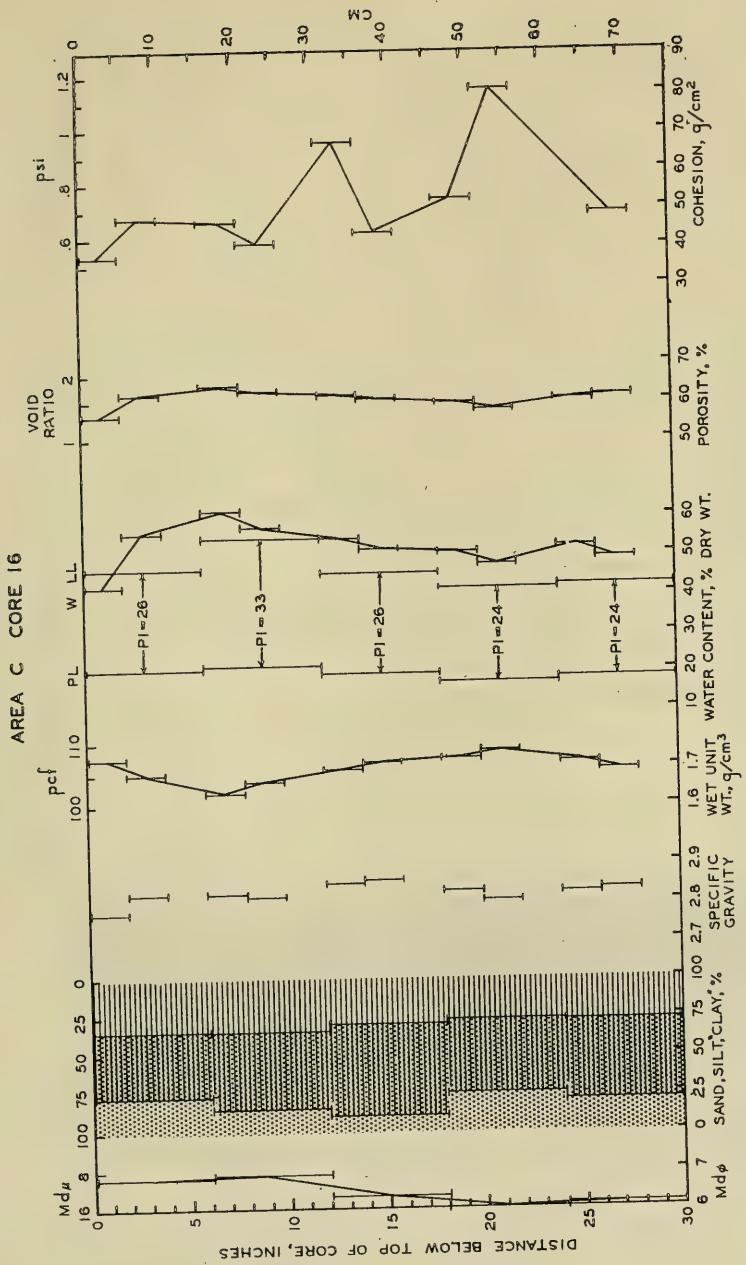
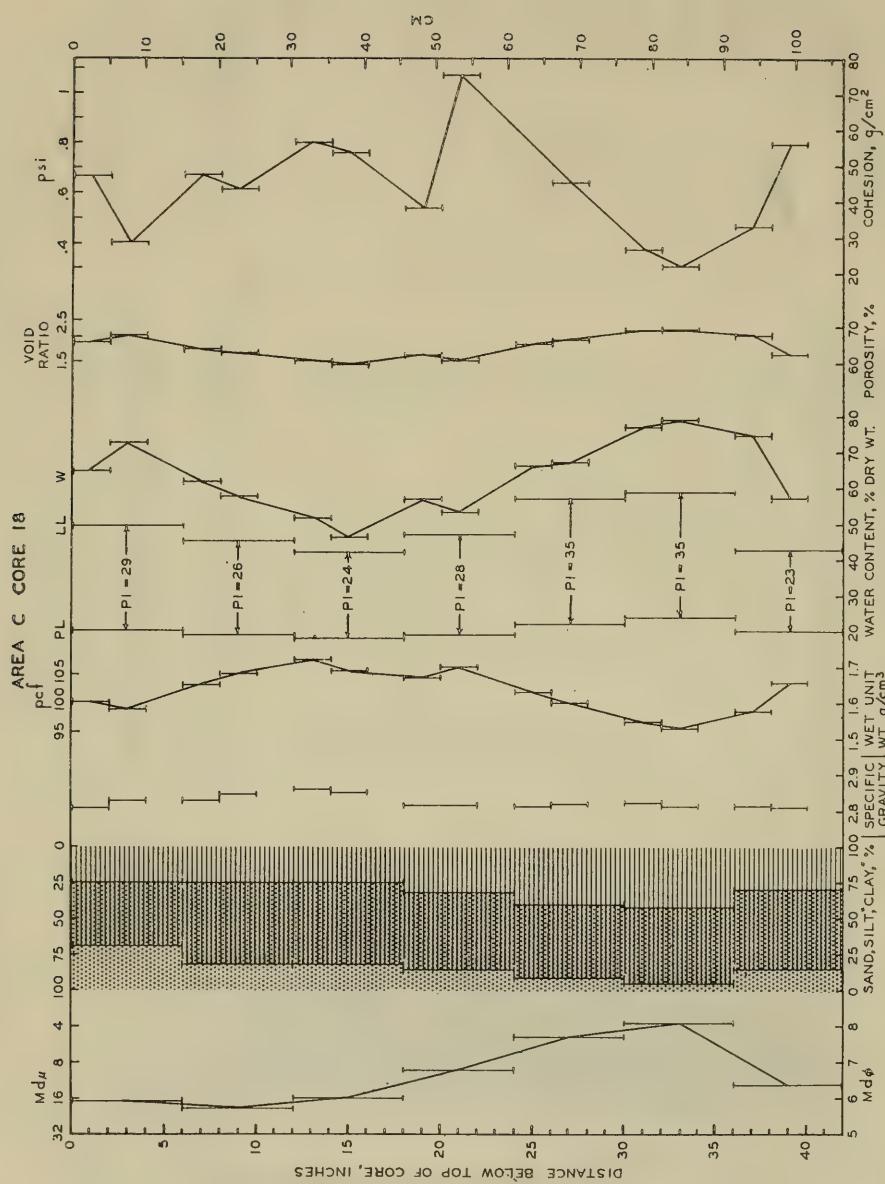


PLATE VII. PARAMETERS VERSUS DEPTH FOR CORE C 16

PLATE VIII. PARAMETERS VERSUS DEPTH FOR CORE C 18



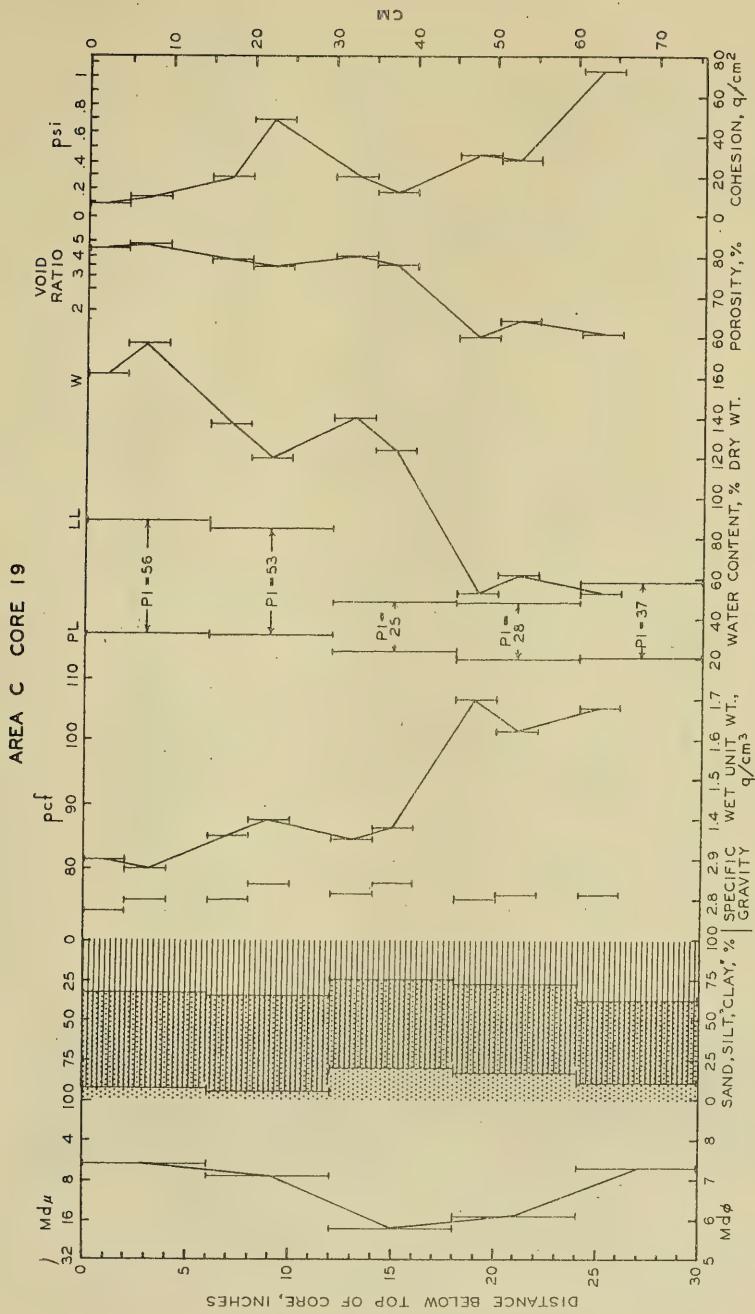


PLATE IX. PARAMETERS VERSUS DEPTH FOR CORE C 19

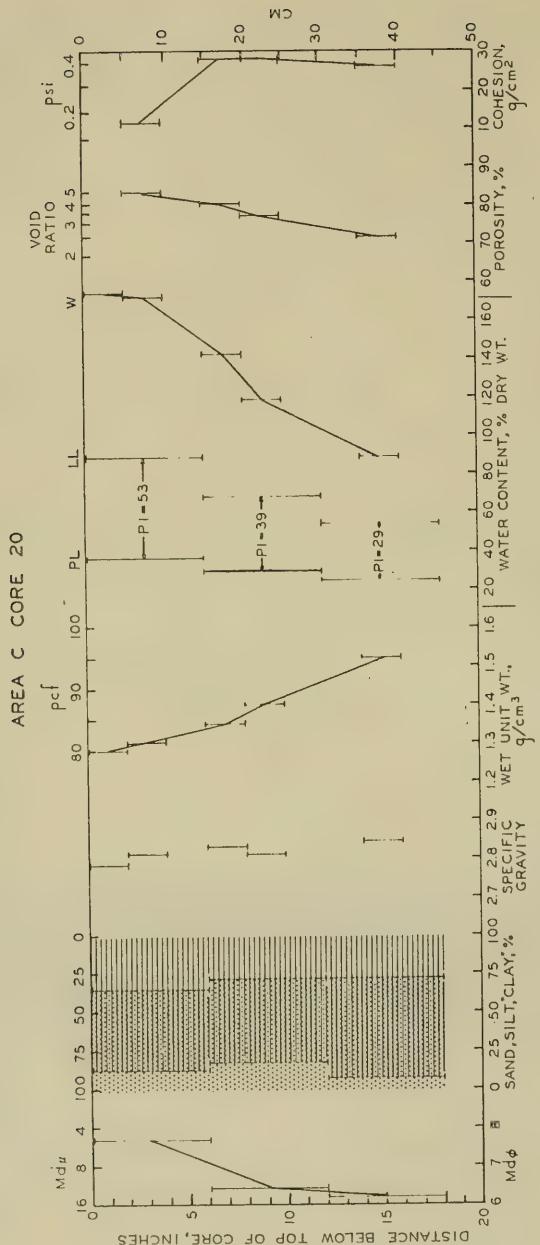


PLATE X. PARAMETERS VERSUS DEPTH FOR CORE C 20

AREA D CORE I (gravity)

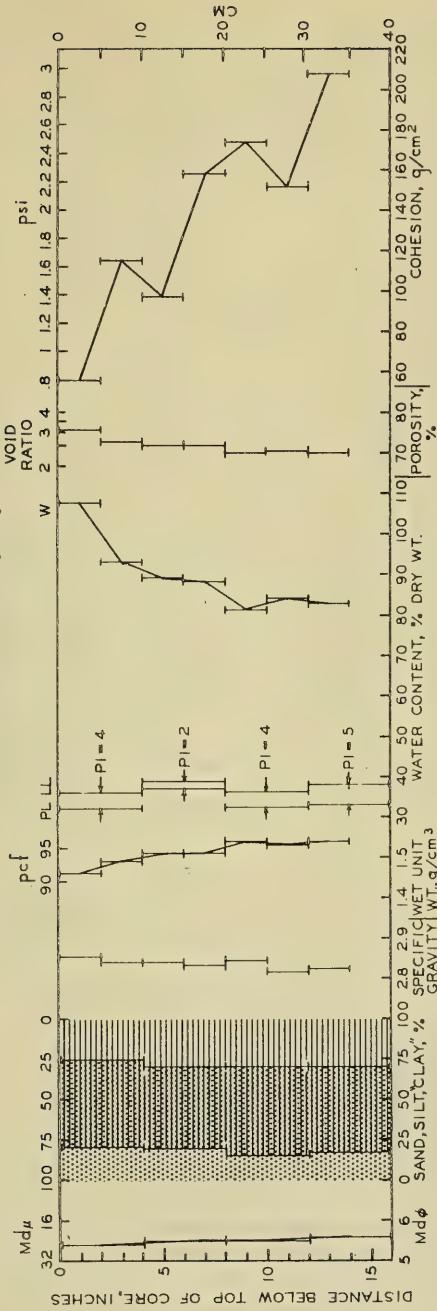


PLATE XI. PARAMETERS VERSUS DEPTH FOR CORE D 1g

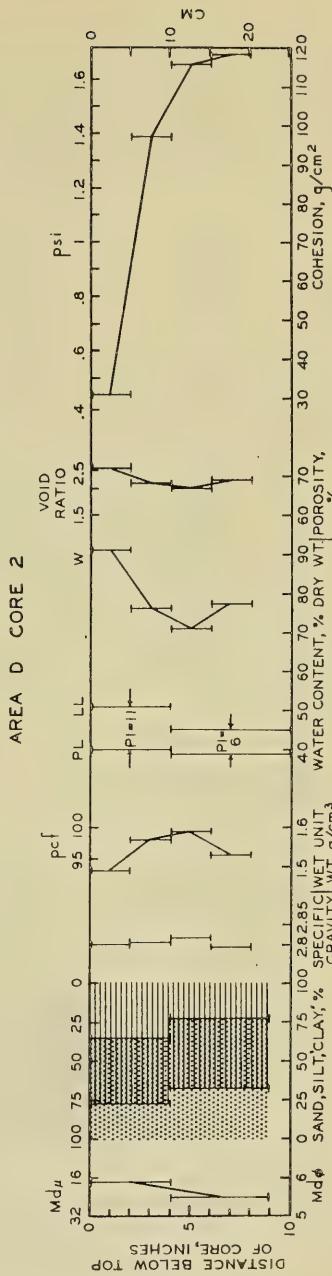


PLATE XII. PARAMETERS VERSUS DEPTH FOR CORE D 2

AREA D CORE I (piston)

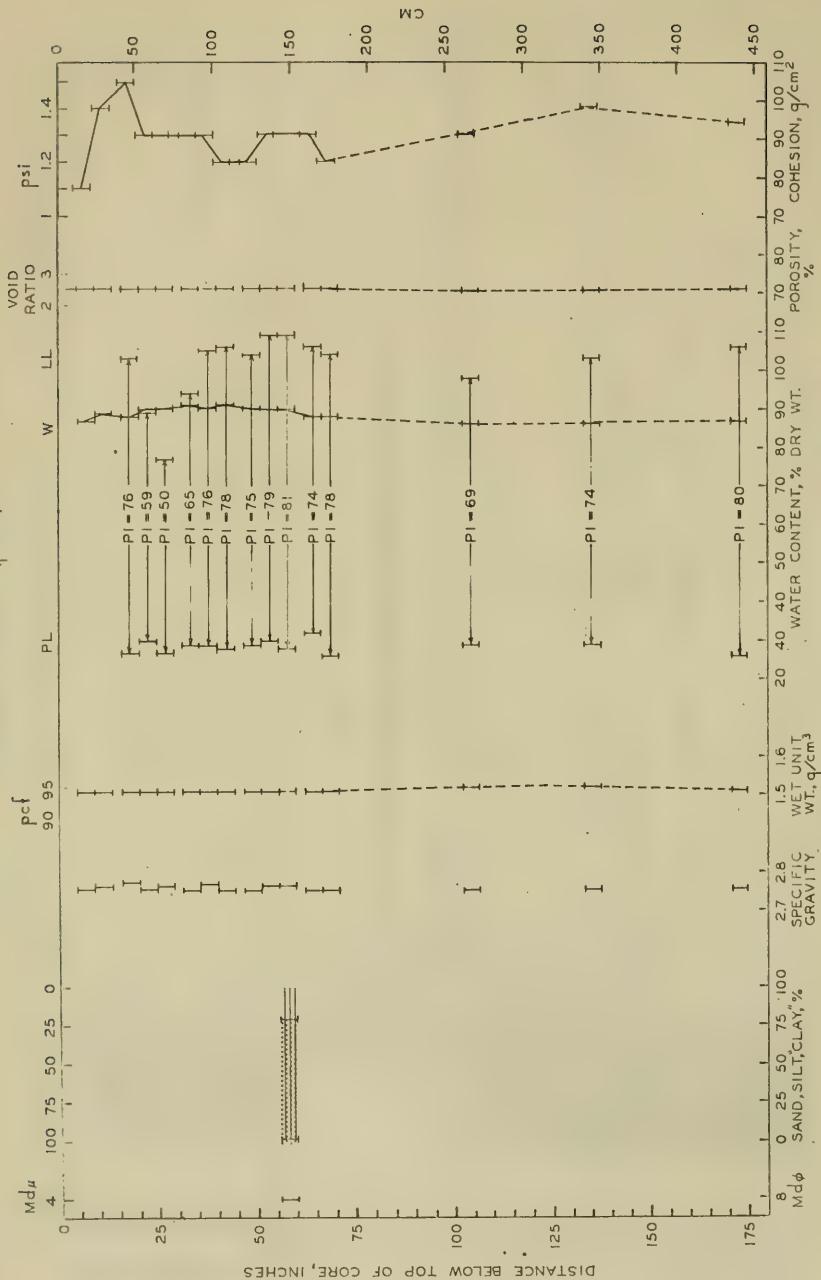


PLATE VIII. PARAMETERS VERSUS DEPTH FOR CORE D 1p

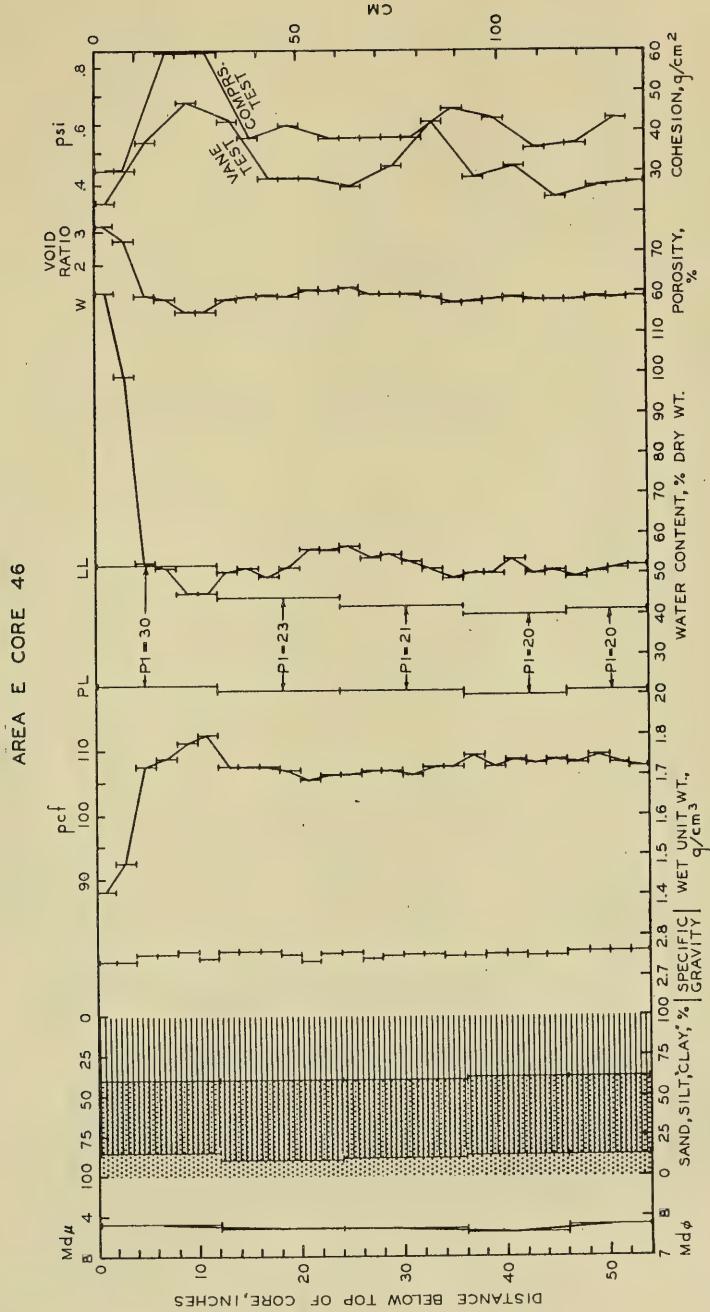


PLATE XIV. PARAMETERS VERSUS DEPTH FOR CORE E 46

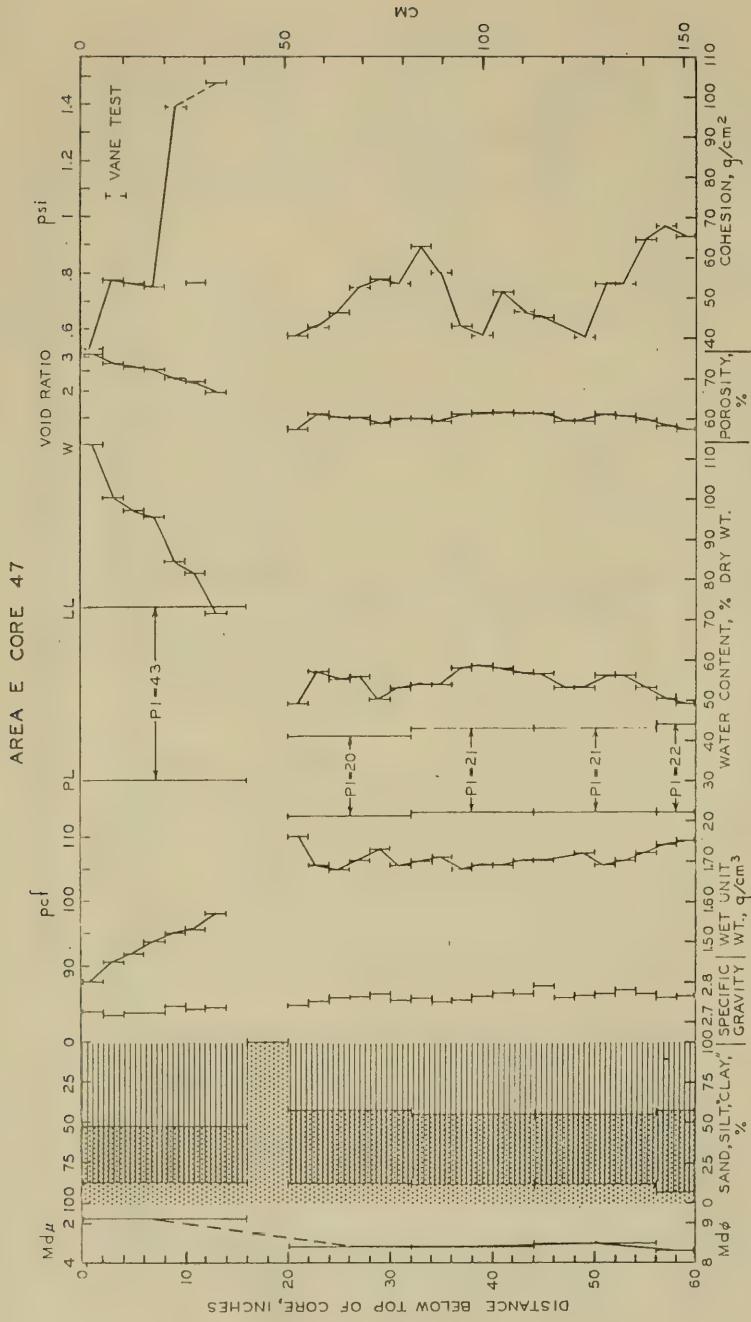


PLATE XV. PARAMETERS VERSUS DEPTH FOR CORE E 47

AREA E CORRE 48

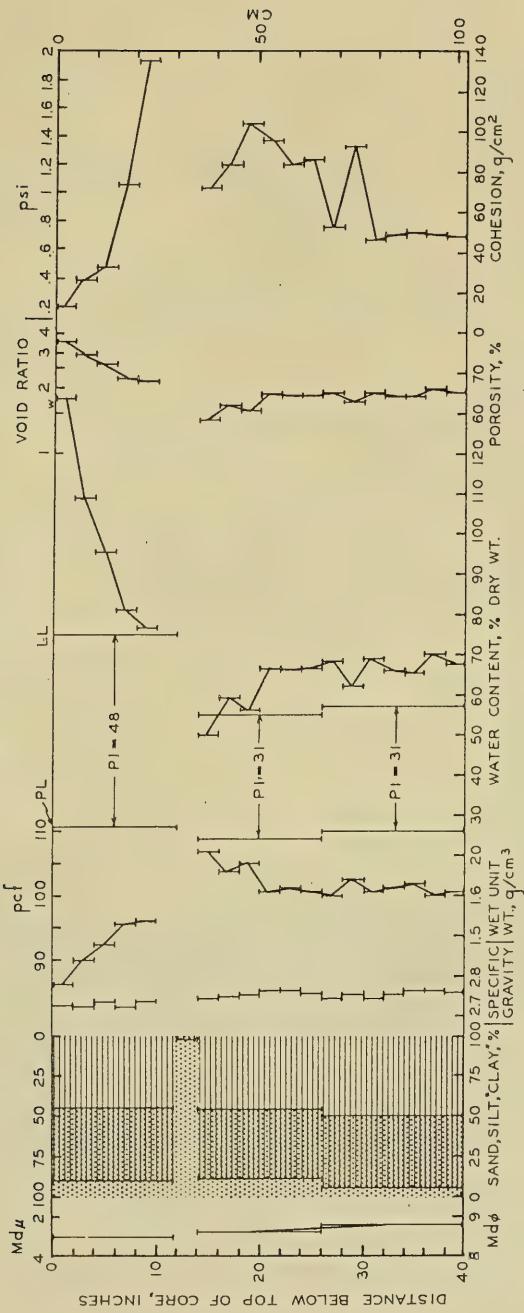
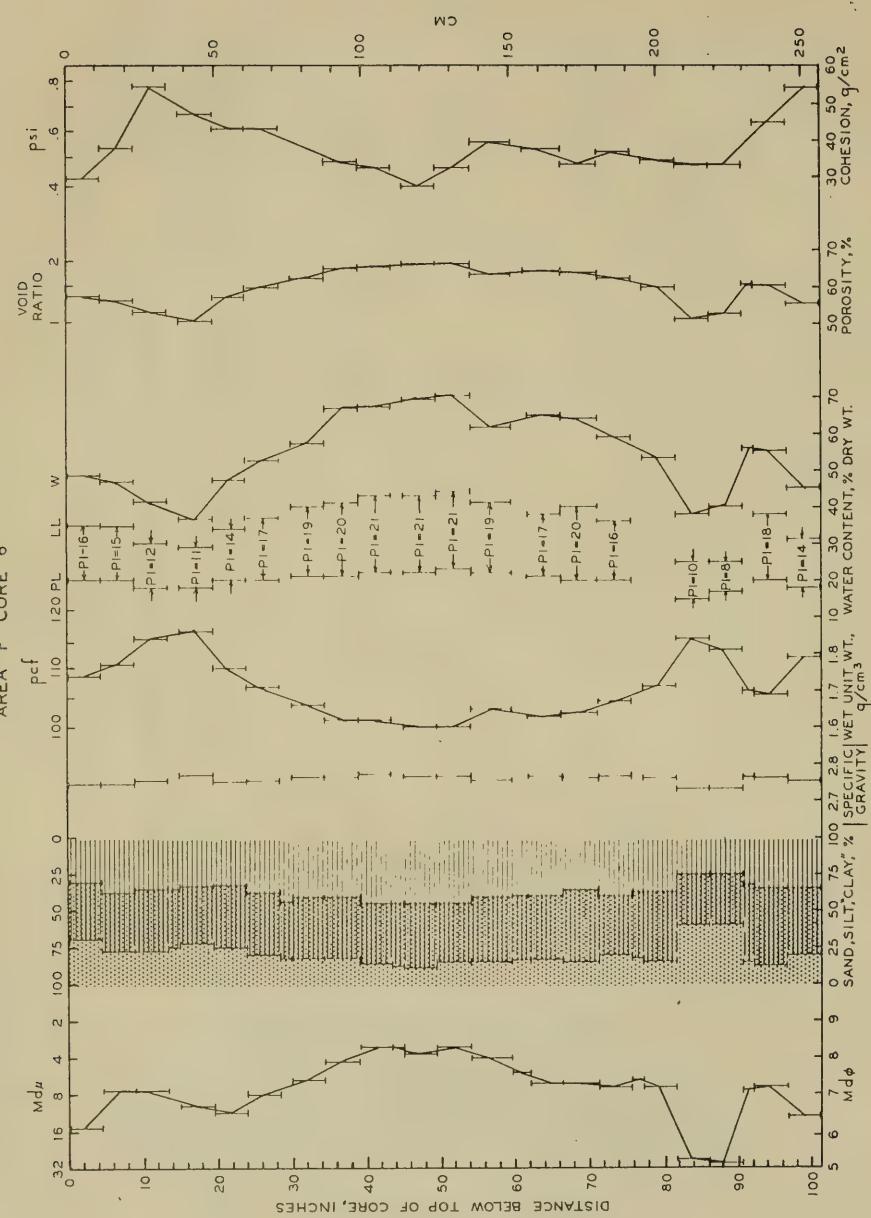


PLATE XVI. PARAMETERS VERSUS DEPTH FOR CORE E 48

PLATE XVII. PARAMETERS VERSUS DEPTH FOR CORE F 6



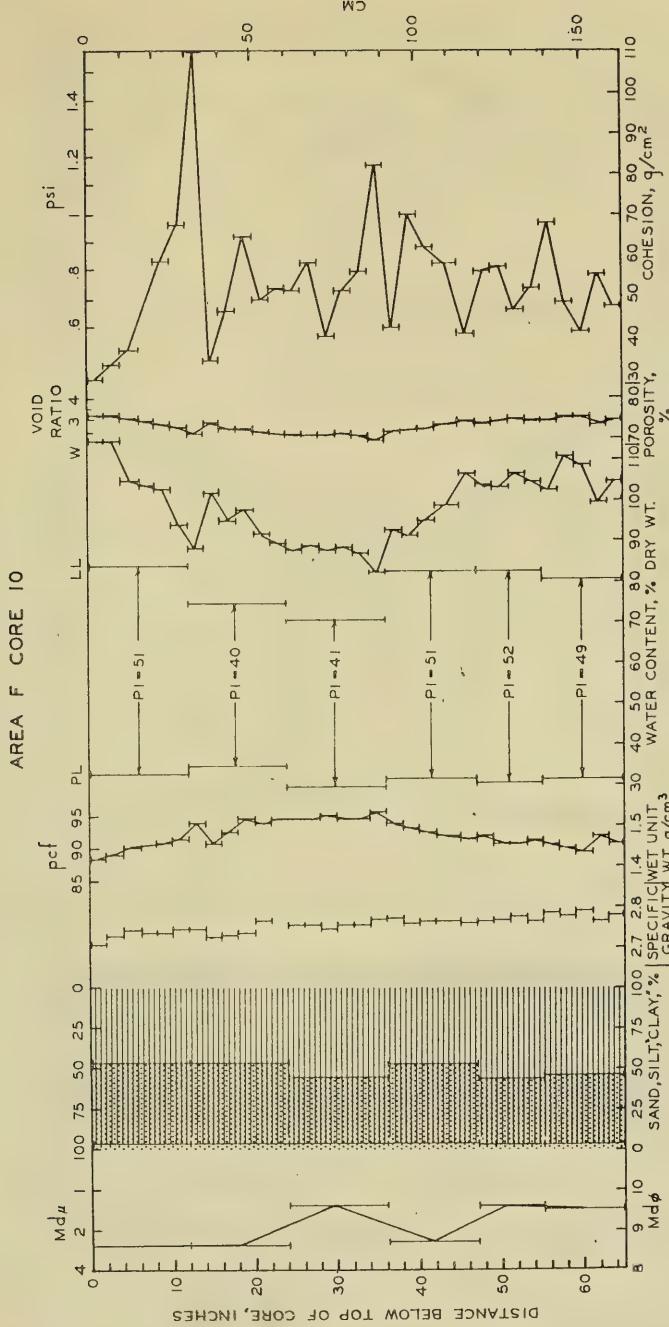


PLATE XVIII. PARAMETERS VERSUS DEPTH FOR CORE F 10

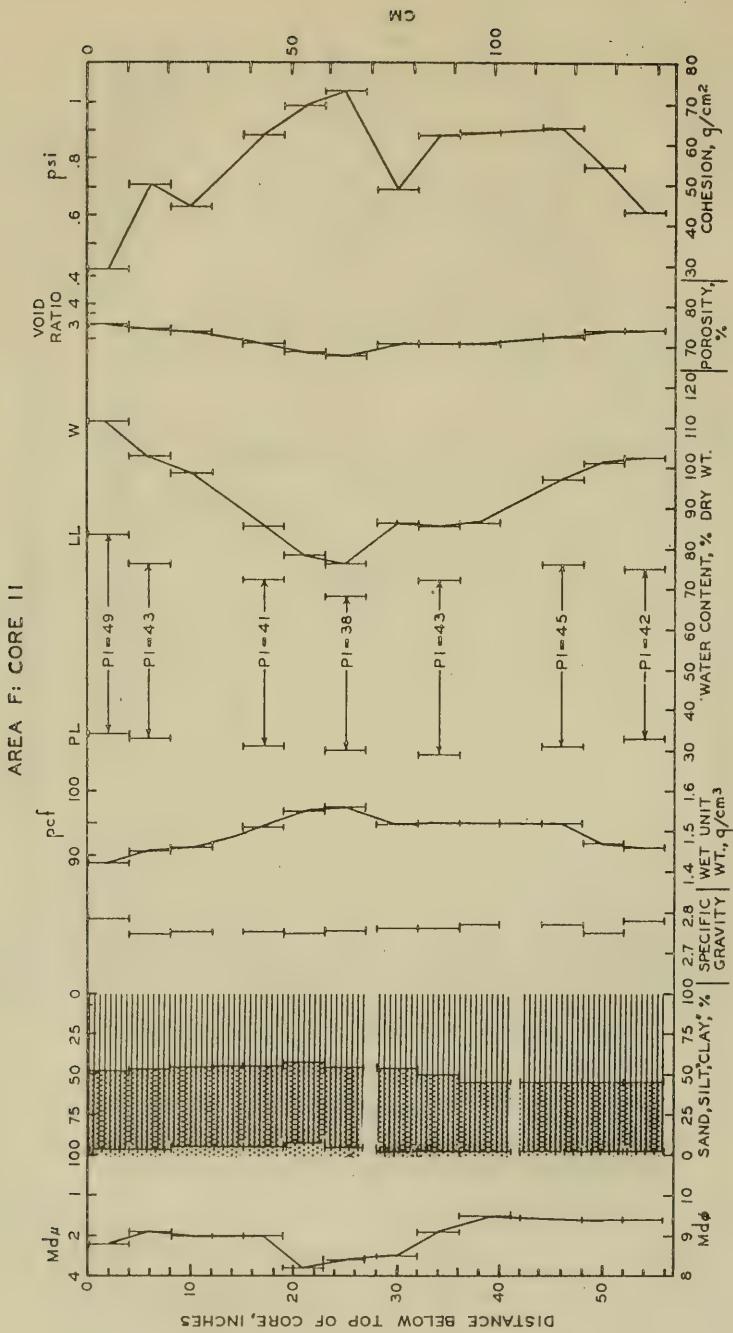


PLATE XIX. PARAMETERS VERSUS DEPTH FOR CORE F 11

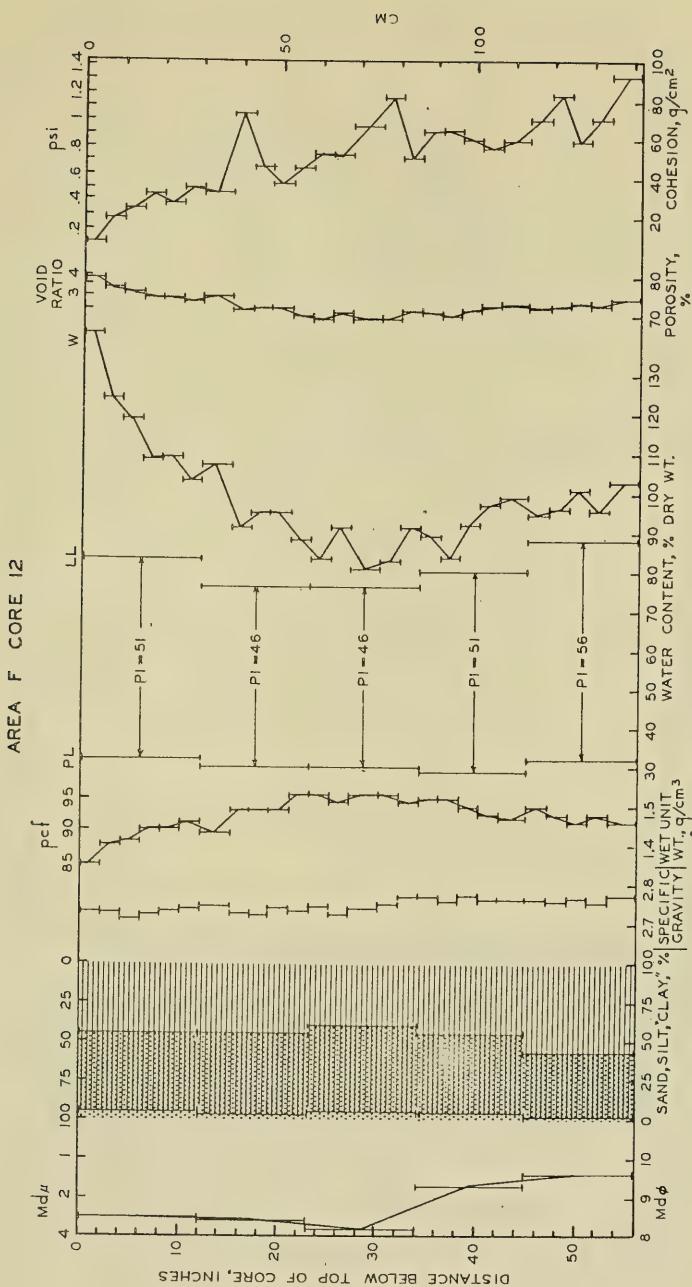


PLATE XX. PARAMETERS VERSUS DEPTH FOR CORE F 12

AREA F CORE 13

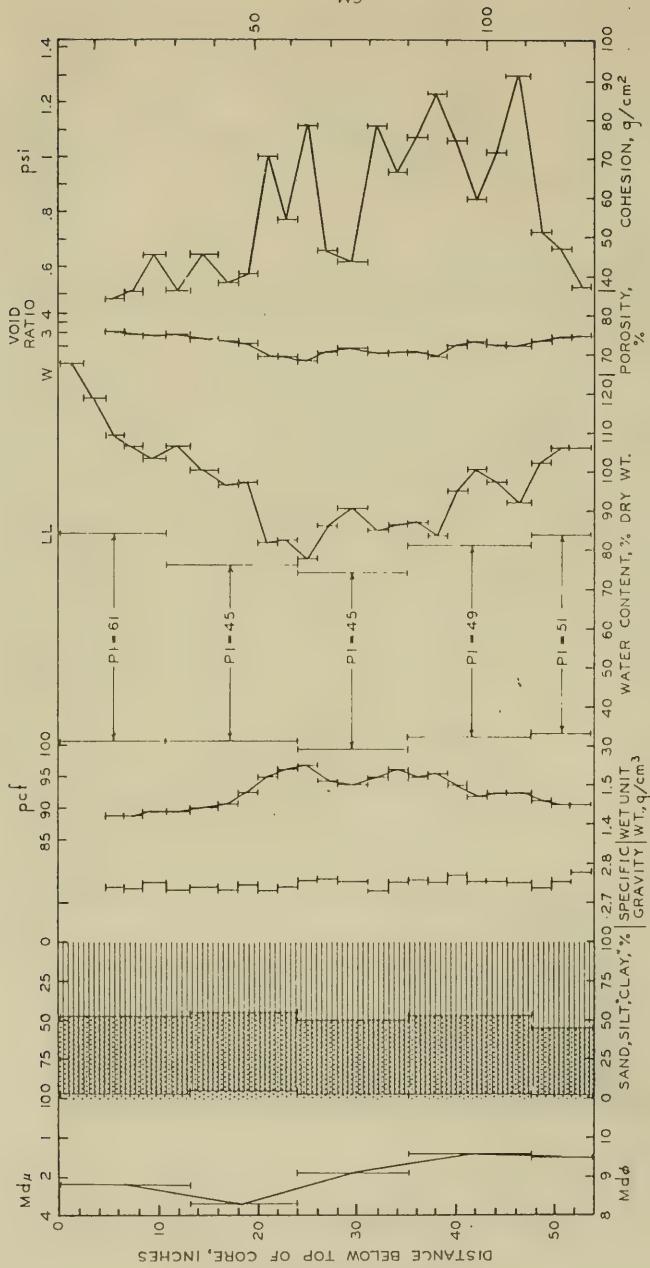


PLATE XXI. PARAMETERS VERSUS DEPTH FOR CORE F 13

AREA F CORE 14

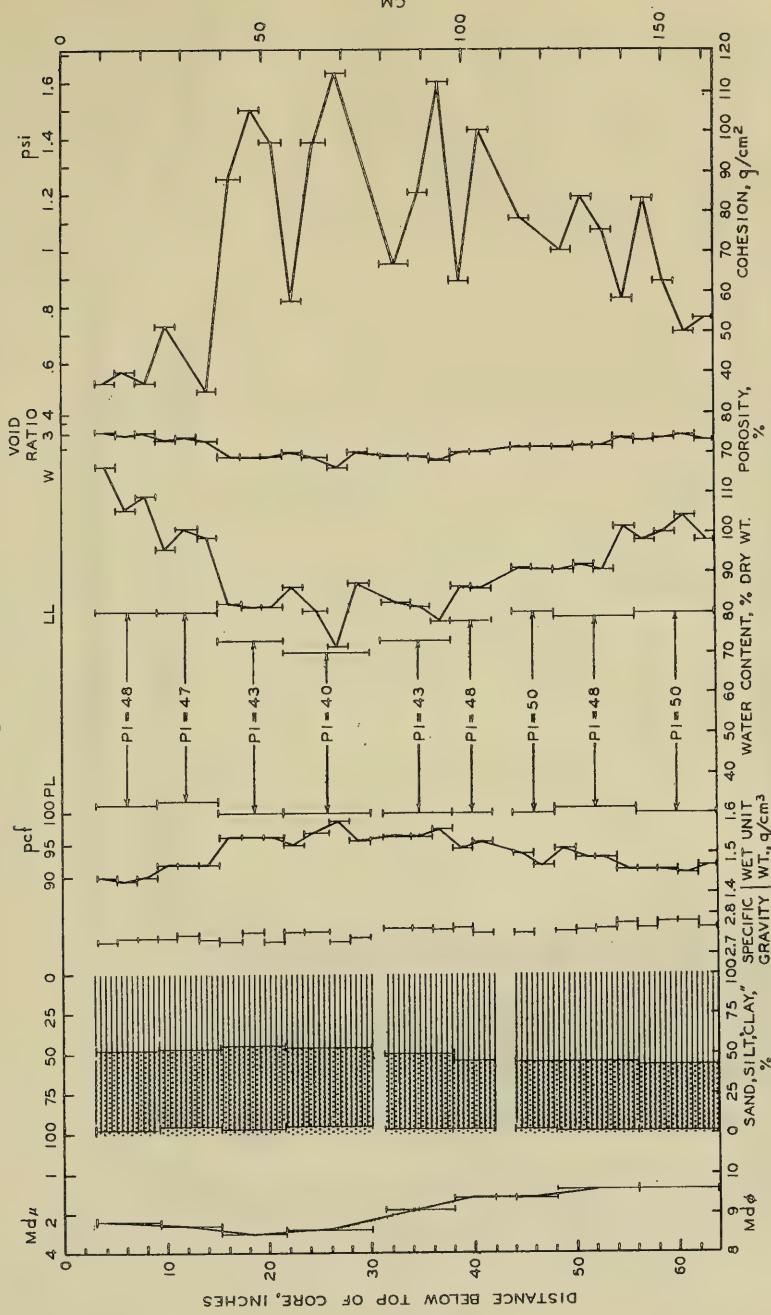


PLATE XXII. PARAMETERS VERSUS DEPTH FOR CORE F 14

AREA F: CORE 15

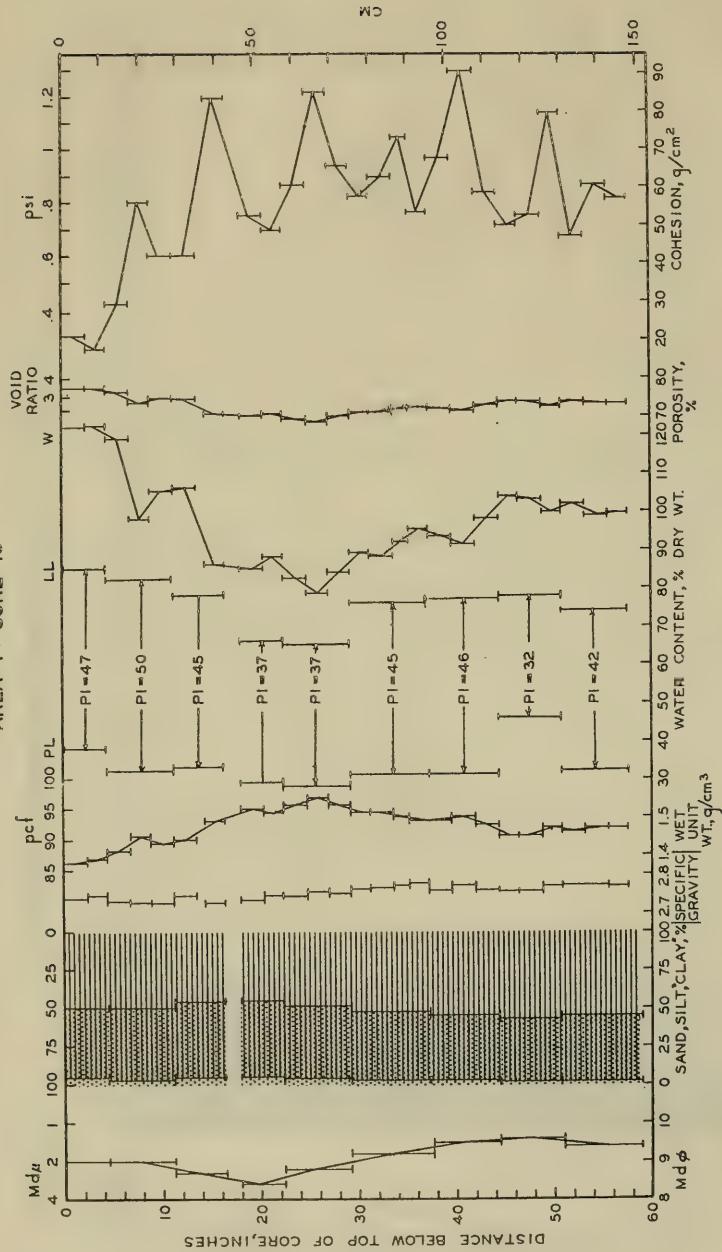


PLATE XXIII. PARAMETERS VERSUS DEPTH FOR CORE F 15

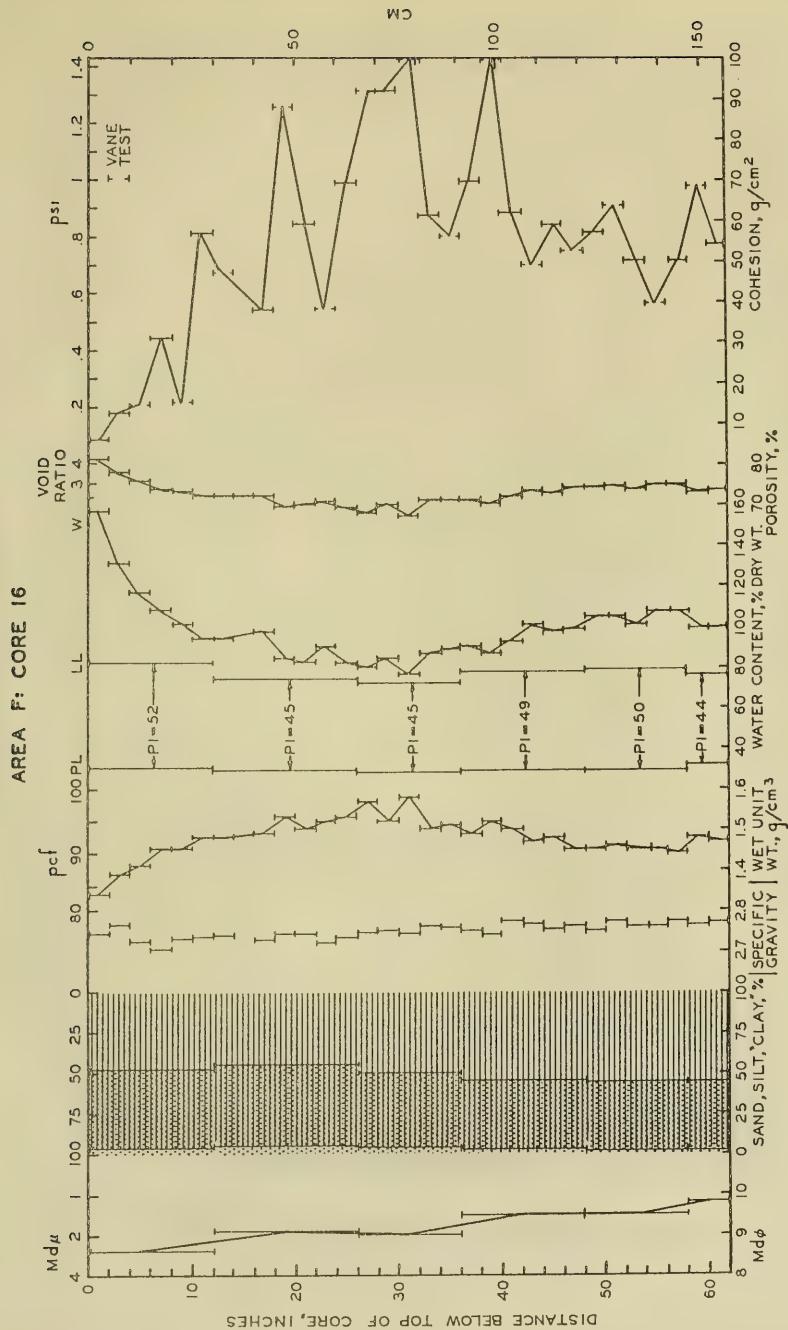


PLATE XXIV. PARAMETERS VERSUS DEPTH FOR CORE F 16

AREA G CORE 2

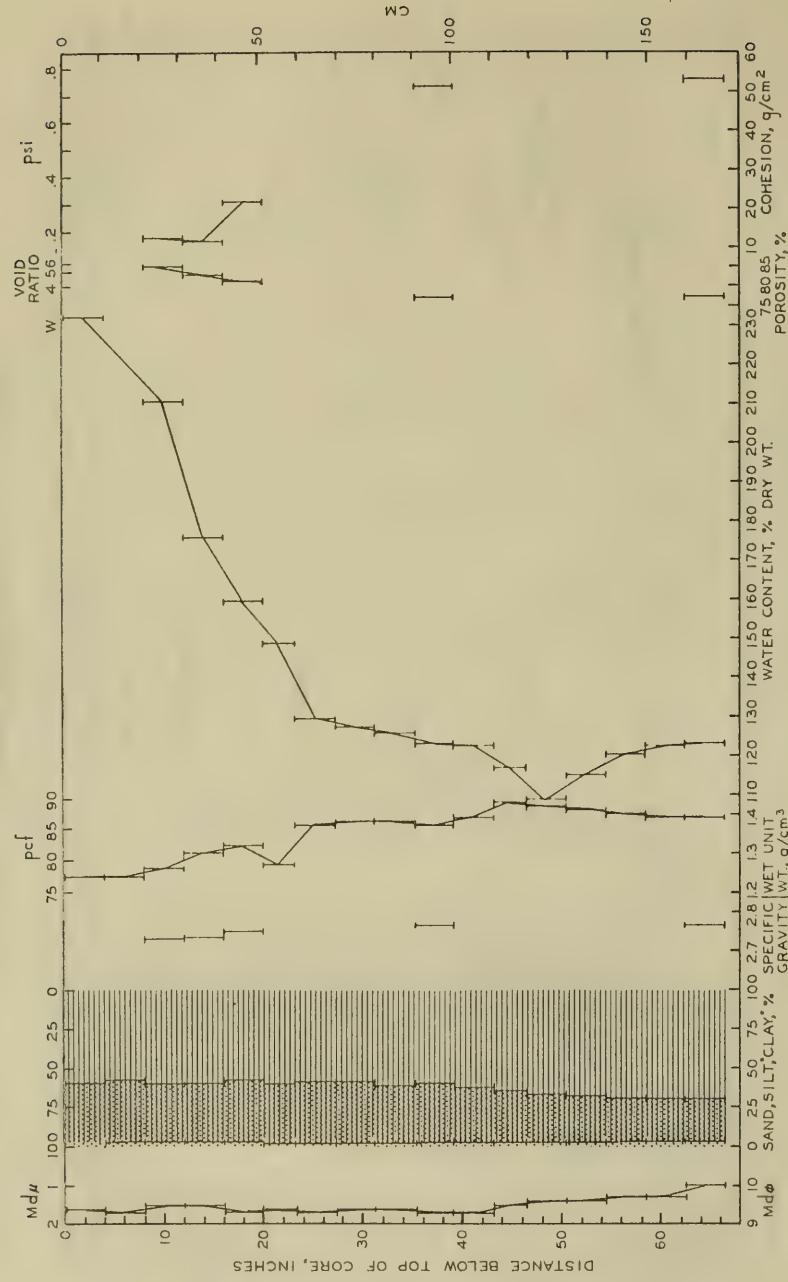


PLATE XXXV. PARAMETERS VERSUS DEPTH FOR CORE G 2

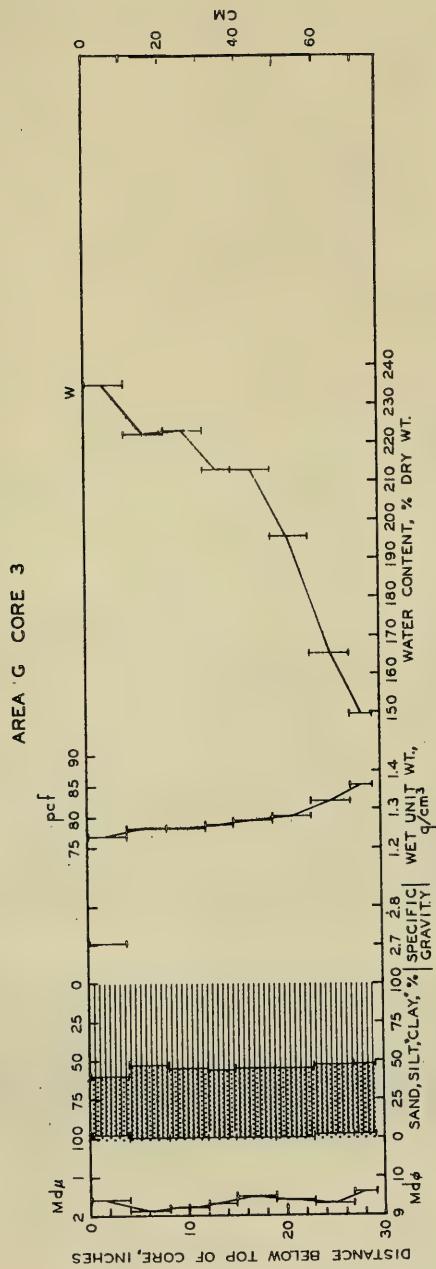


PLATE XXVI. PARAMETERS VERSUS DEPTH FOR CORE G 3

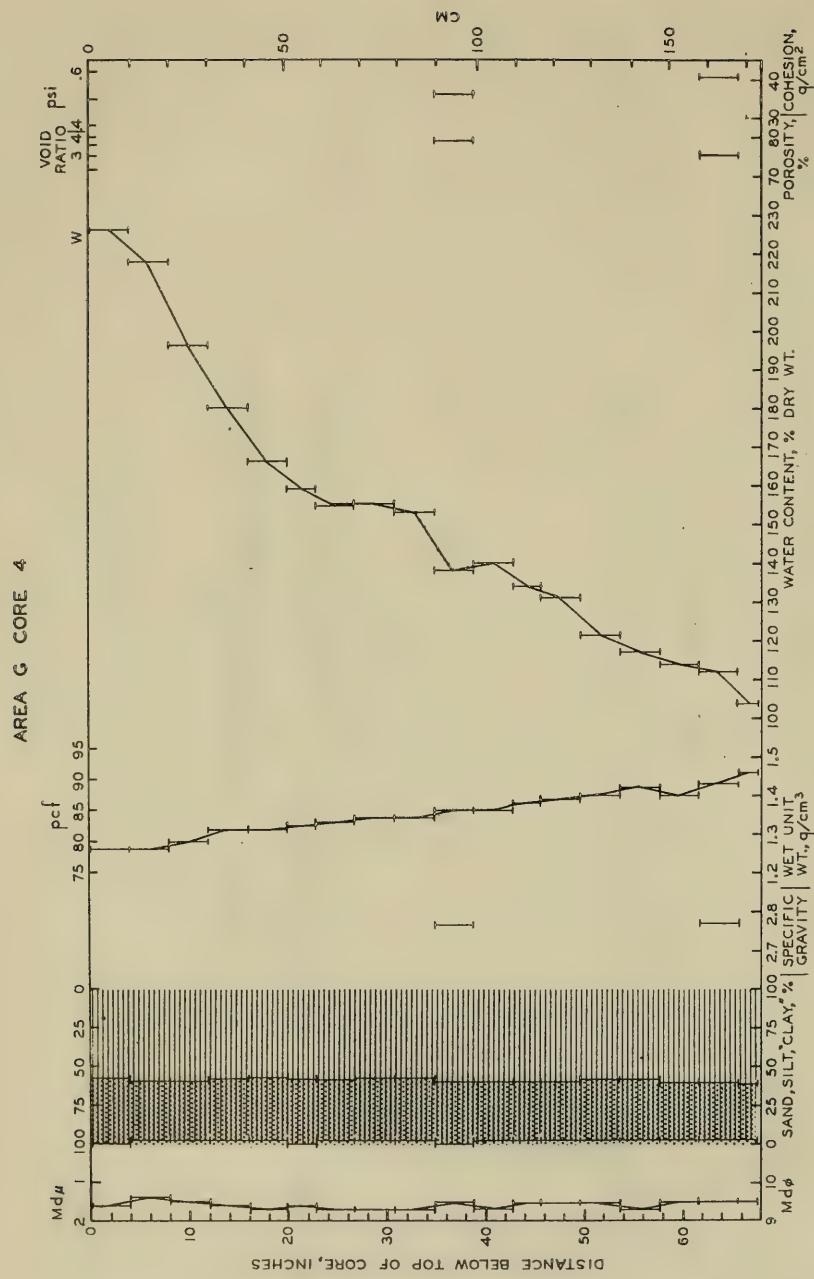


PLATE XXVII. PARAMETERS VERSUS DEPTH FOR CORE G 4

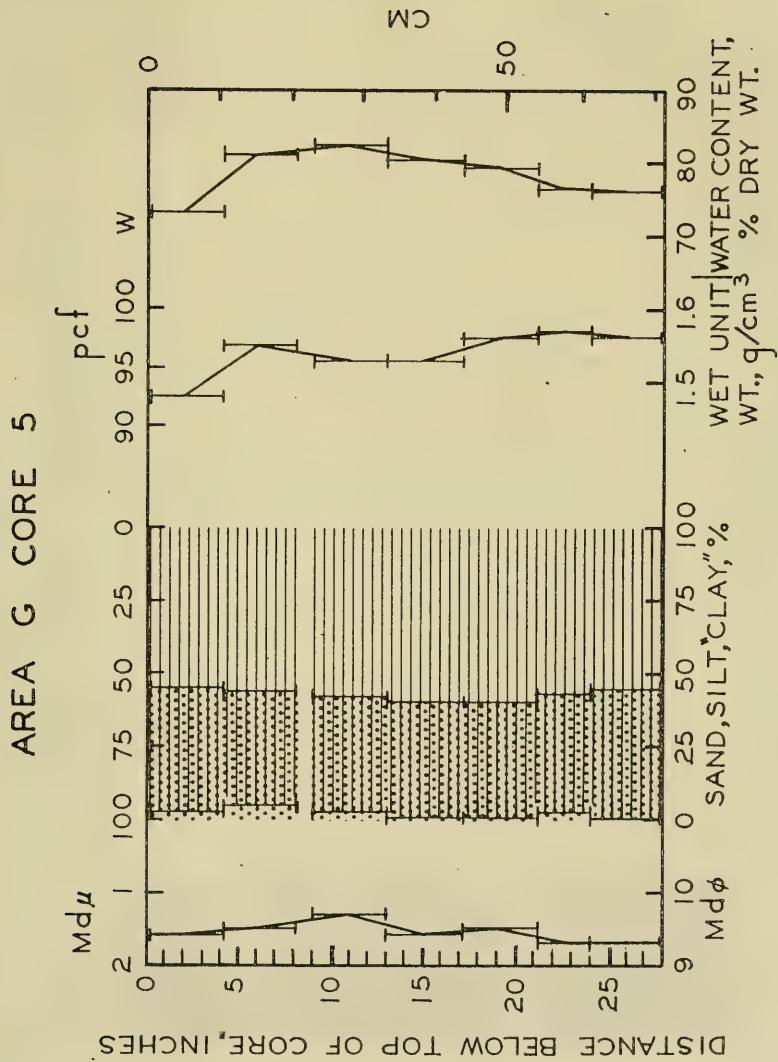


PLATE XXVIII. PARAMETERS VERSUS DEPTH FOR CORE G 5

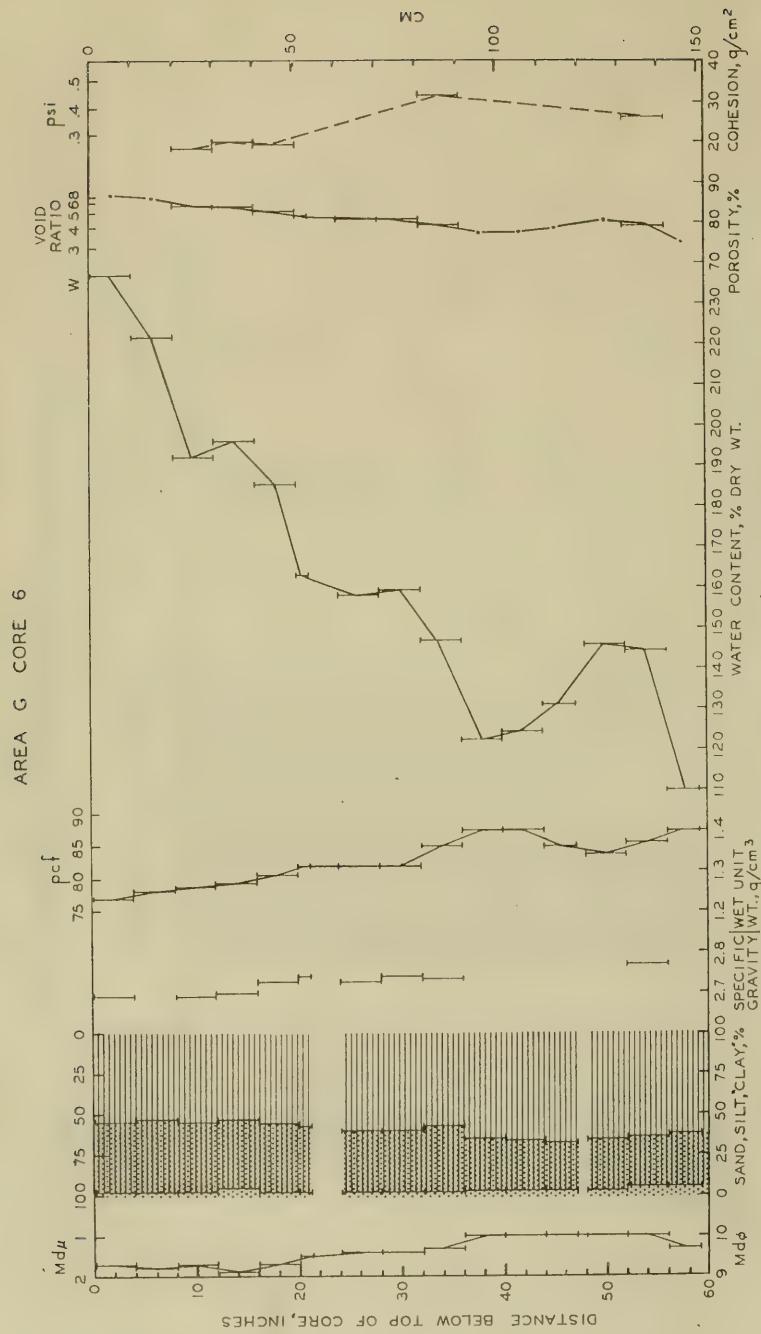


PLATE XXIX. PARAMETERS VERSUS DEPTH FOR CORE G 6

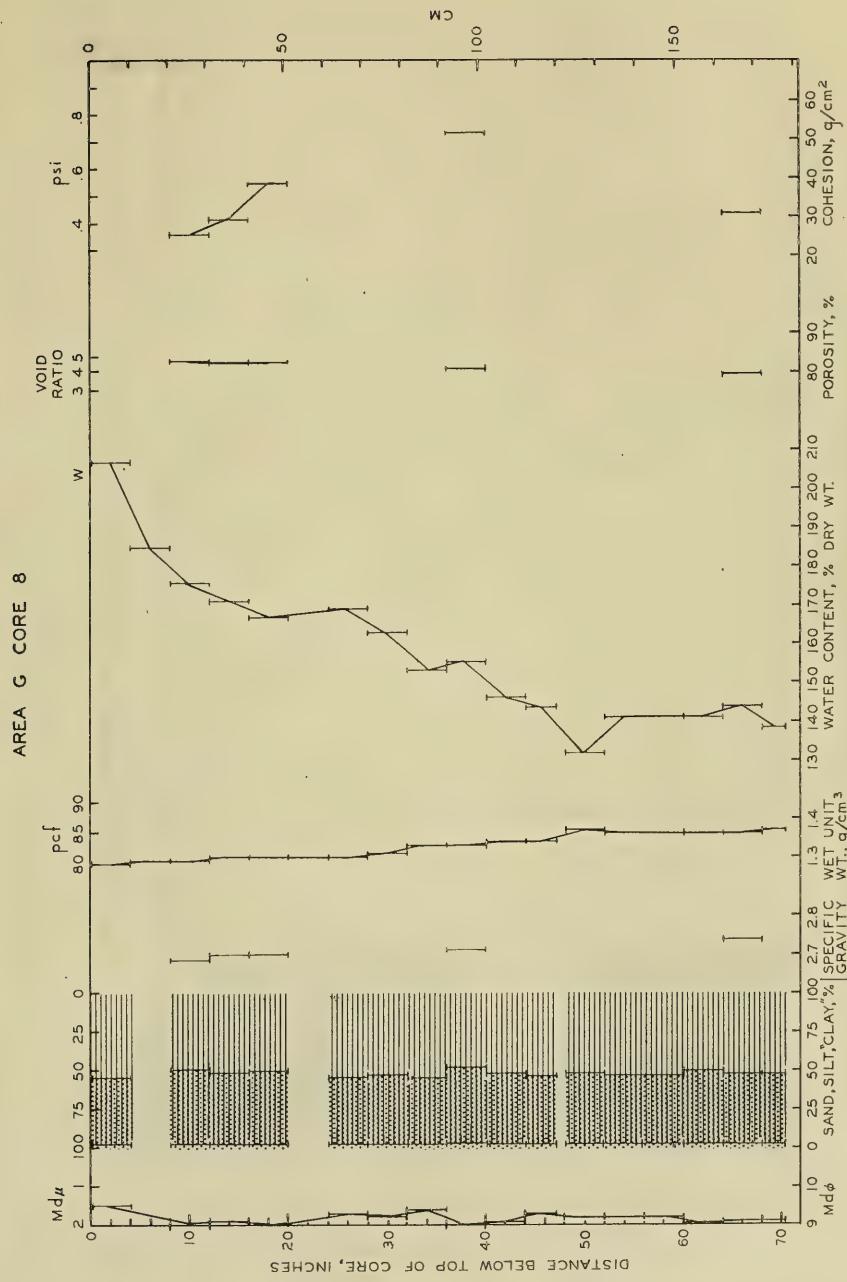


PLATE XXX. PARAMETERS VERSUS DEPTH FOR CORE G 8

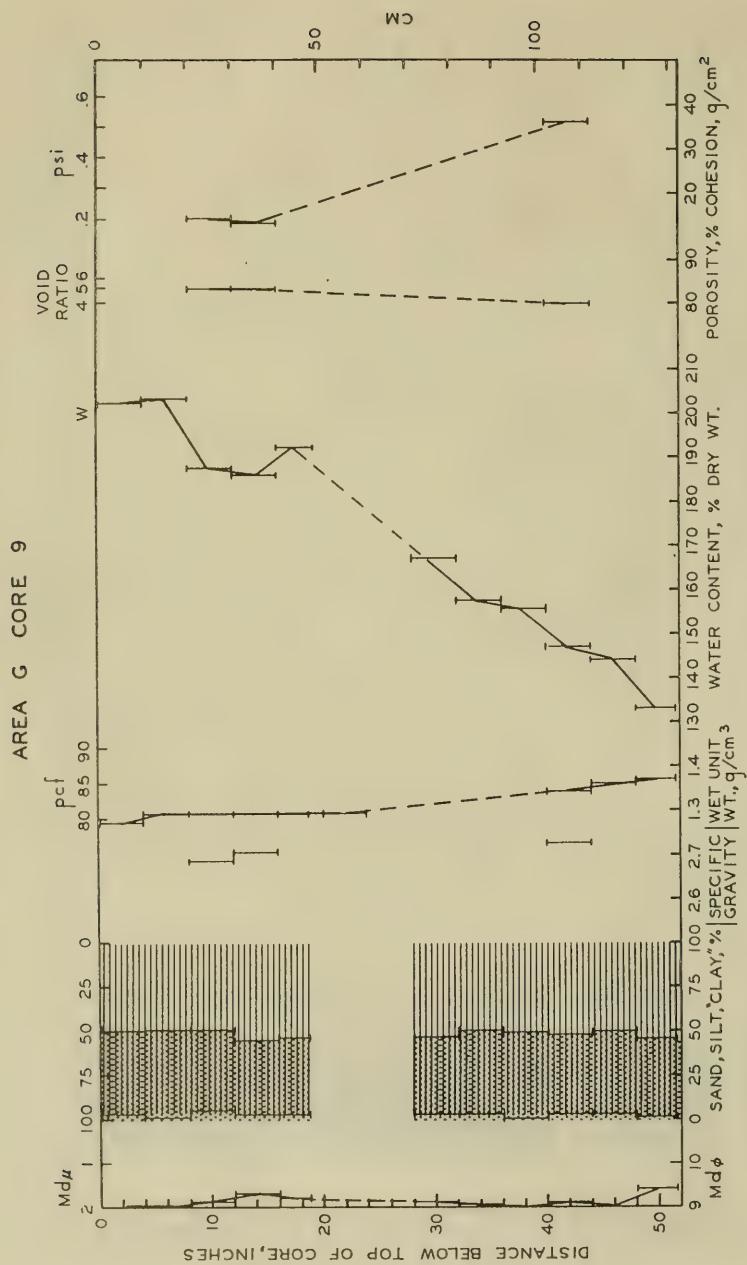


PLATE XXXI. PARAMETERS VERSUS DEPTH FOR CORE G 9

AREA G CORE 10

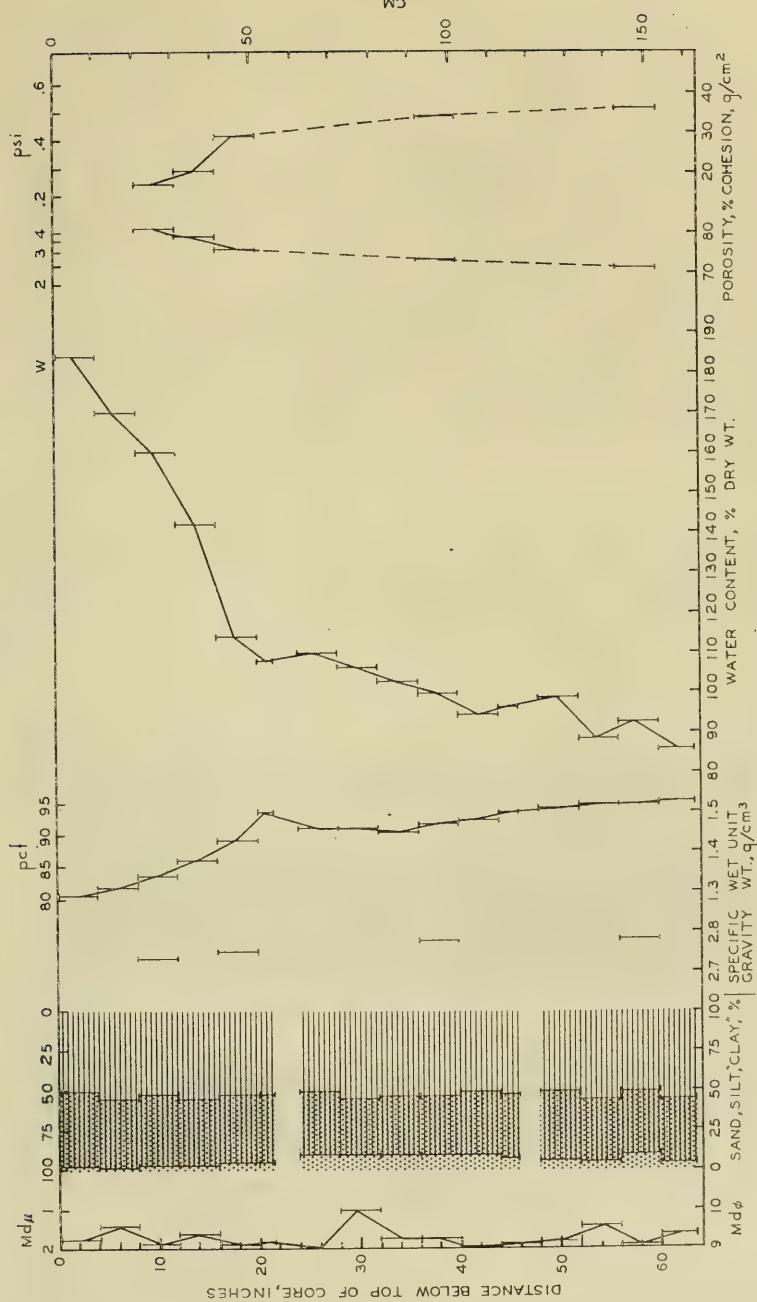


PLATE XXXII. PARAMETERS VERSUS DEPTH FOR CORE G 10

AREA G CORE II

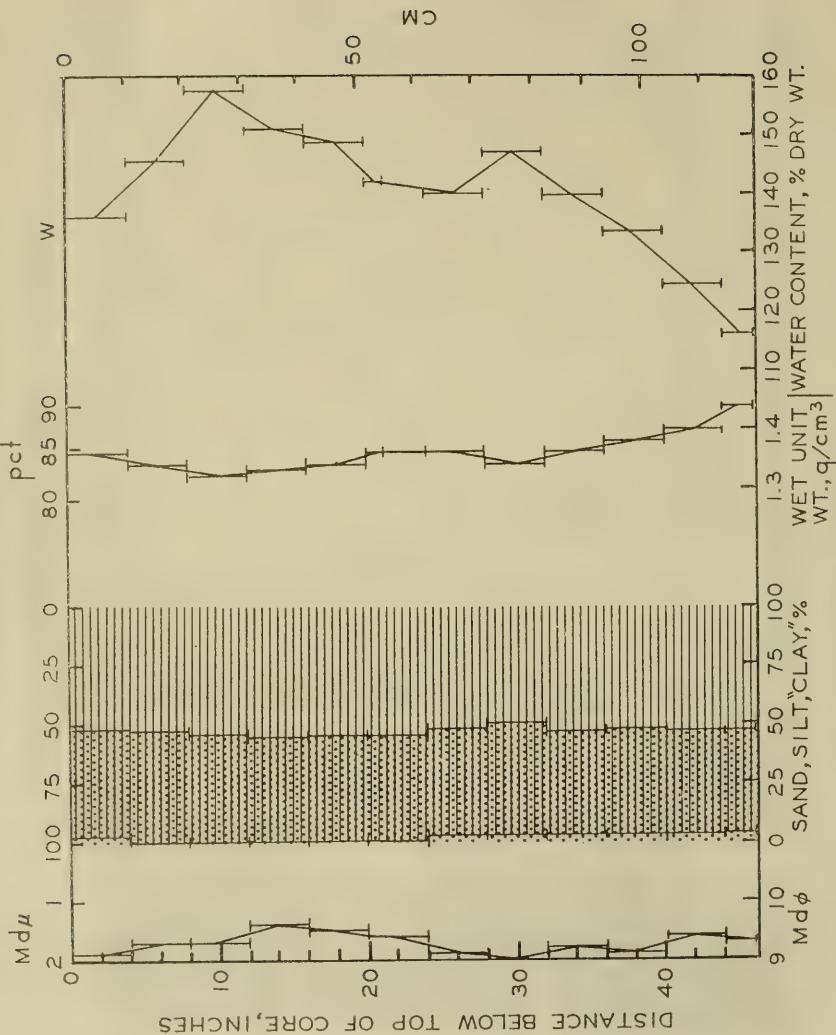


PLATE XXXIII. PARAMETERS VERSUS DEPTH FOR CORE G II

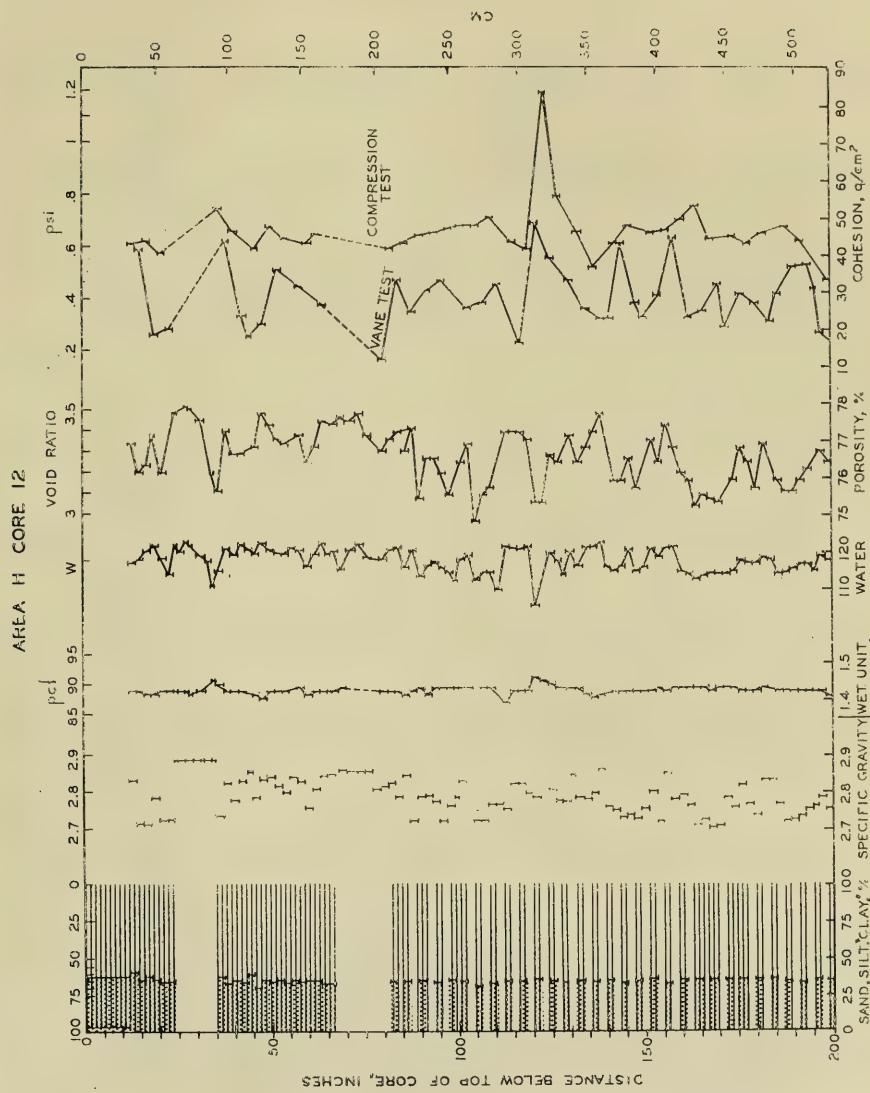


PLATE XXXIV. PARAMETERS VERSUS DEPTH FOR CORE H 12

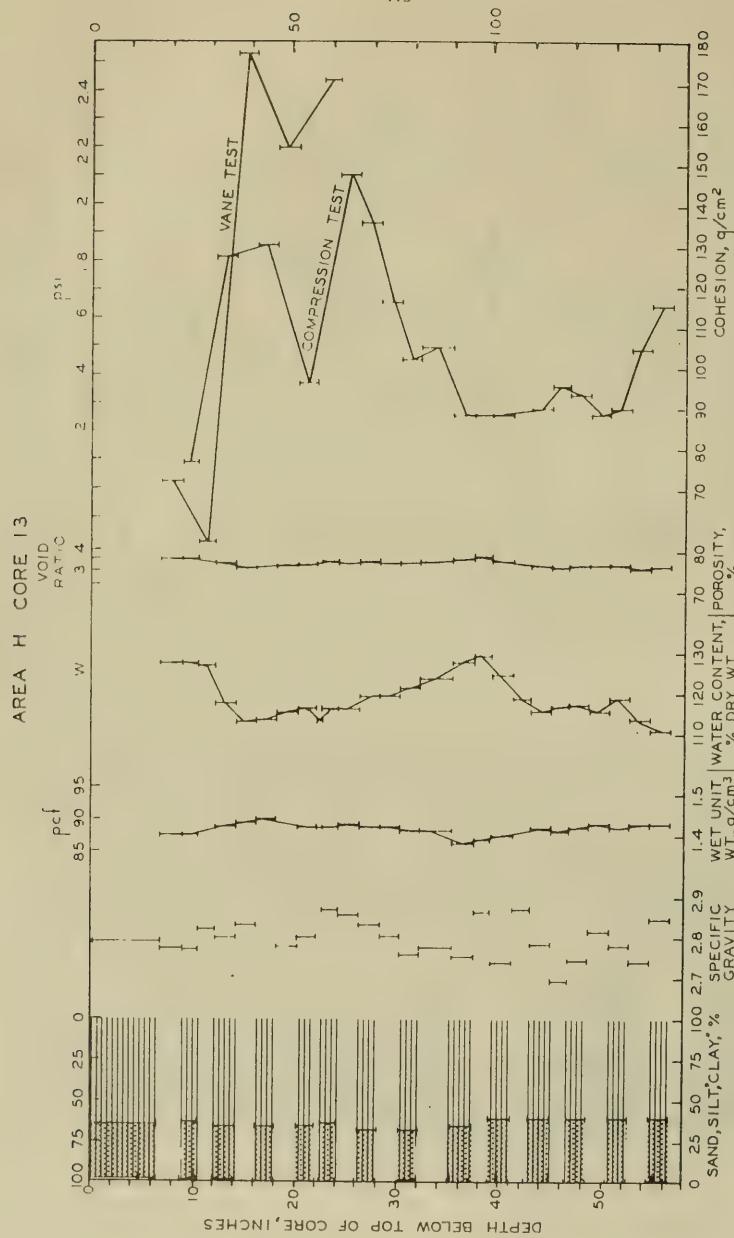


PLATE XXXV. PARAMETERS VERSUS DEPTH FOR CORE H 13

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APPENDIX A.

SALINITY CORRECTION FOR SPECIFIC GRAVITY MEASUREMENTS

Unanimity of opinion does not exist at present on the salt content or salinity¹² of interstitial waters of marine sediments. Physical measurements based on assumed oceanic salinity of pore water (for example, Ratcliffe, 1960, p. 1536) may be of questionable validity until the distribution of interstitial salinity is better known. Arrhenius (1952, p. 78-79) reported a linear correlation between salinity and water content in deep-sea Pacific and Atlantic Ocean cores. Salinity varied markedly with depth in most east Pacific cores (Arrhenius, 1952, Appendix plates 1-62). Emery and Rittenberg (1952, p. 803) in studies of cores from basins off Southern California found that the salinities of interstitial waters were relatively constant with depth of burial. Pore water chlorinity was slightly greater than 19 parts per thousand (p. 788-789), which represents a salinity of about 35 parts per thousand--a normal oceanic value. A more variable relationship of salinity to depth is reported by Shepard and Moore (1955, p. 1582) and Sutton and others (1957, p. 792-793).

Hamilton and Menard (1956, p. 755) give a formula correcting grain density, or specific gravity of particles, for salt content and discuss procedure.

¹²The definition of salinity is "the total amount of solid material in grams contained in one kilogram of sea water when all the carbonate has been converted to oxide, the bromine and iodine replaced by chlorine, and all organic matter completely oxidized" (Sverdrup, and others, 1946, p. 50). Salinity, in consequence, is not strictly speaking synonymous with salt content, although it is often used in synonymy.

APPENDIX B

DATA TABLE FOR EACH CORE TESTED

All parameters listed in the data tables have been defined and discussed in the text, except the compression index and slump. The compression index, C_c , is defined (ASCE) as the slope of the linear portion of the void ratio-logarithm of pressure, p , (e -log p) curve, or

$$C_c = \frac{e_i - e_f}{\log_{10} \frac{P_f}{P_i}} \quad (23)$$

where subscripts i and f are respectively the initial and final conditions. Skempton (1944, p. 126) demonstrated a straight-line, linear relationship between the compression index and liquid limit, LL. This relation is defined (Terzaghi and Peck, 1948, p. 66) as

$$C_c = 0.009 (LL - 10\%). \quad (24)$$

Compression indices in the tables were determined from the liquid limit in accordance with equation 24 and from the laboratory e -log p curves by equation 23. These figures will be used and discussed in the report on consolidation, which is in preparation.

Slump percentage is the ratio of the amount of height change immediately before the compressive strength test to the original height of a cylinder of the sediment. Certain samples slumped under their own weight before the compressive strength test could be started.

Porosities were estimated from assumed specific gravities (equations 12 and 14) in certain Area G cores. All such estimated data are shown within parentheses in the tables.

AREA A CORE 23

CRUISE: 1958 SONIC DEPTH, UNCORRECTED: 620 fms. CORER: 400 lb. Gravity Kullenberg
 APPROX. CORER PENETRATION: 60 IN. CORE: 30 in. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	
WET UNIT WEIGHT, g/cm ³	16.4 ± 3	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	16.9	
SPECIFIC GRAVITY OF SOLIDS	1.36	1.44	1.46	1.48	1.48	1.49	1.51	1.52	1.53	1.55	1.55	1.55	1.55	1.55	1.55	
WATER CONTENT, % DRY WEIGHT	2.791	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VOID RATIO DETERMINED IN LAB.	125.42	109.34	-	101.18	93.60	-	91.43	87.41	-	83.40	82.33	-	79.16	77.33	-	
POOROSITY AT 100% SATURATION, %	3.665	3.058	-	2.818	2.608	-	2.570	2.461	-	2.364	2.323	-	2.229	2.196	-	
SATURATION, %	78.4	75.4	-	73.8	72.5	-	72.1	71.2	-	70.4	70.0	-	69.2	68.7	-	
LIQUID LIMIT	96.6	99.8	-	99.2	99.2	-	99.2	99.0	-	98.6	99.1	-	99.3	98.4	-	
PLASTIC LIMIT	78	-	-	75	-	-	75	-	-	72	-	-	74	-	-	
LIQUIDITY INDEX, %	300	166	-	138	142	-	137	128	-	126	124	-	111	107	-	
PLASTICITY INDEX	47	-	-	45	-	-	43	-	-	42	-	-	45	-	-	
COMPRESSION INDEX FROM LL	0.61	-	-	0.59	-	-	0.59	-	-	0.56	-	-	0.58	-	-	
COMPRESSION INDEX FROM e-log P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SLUMP, %	9.25	4.00	-	5.00	2.60	-	1.60	2.10	-	1.50	1.05	-	1.15	0.65	-	
COMPRESSIVE "UNDISTURBED", PSI	0.12	0.28	-	0.33	0.48	-	0.54	0.74	-	0.84	0.90	-	1.05	0.98	-	
STRENGTH REMOLDED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, PSI	0.06	0.14	-	0.17	0.24	-	0.27	0.37	-	0.12	0.45	-	0.53	0.49	-	
ACTIVITY	9 cm ⁻²	4.2	9.8	-	11.6	16.8	-	19.0	26.0	-	29.5	31.6	-	36.9	34.4	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAIN MEDIAN DIA., microns	0.4	1.2	-	1.9	4.4	-	5.3	6.4	-	6.6	7.4	-	7.3	8.9	-	
SAND, % > 60 μ < 2 mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SILT, % > 2 μ < 0.06 μ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLAY, % < 2 μ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

AREA A CORE 31

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 220 fms. CORE: 400 lb. Gravity Kullenberg
 APPROX. COHER PENETRATION: 60 in. CORE: 41 in. LONG. DIA.: 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40	40-41
WET UNIT WEIGHT lb ft ⁻³ / gm ⁻³	86.6	91.0	-	91.7	91.2	-	96.7	95.4	-	98.6	100.6	-	101.8	102.0	-	103.9	105.5	-	103.6	102.2	-
SPECIFIC GRAVITY OF SOLIDS	2.795	2.776	-	2.836	2.776	-	2.771	2.783	-	2.793	2.793	-	2.774	2.773	-	2.774	2.789	-	2.769	2.766	-
WATER CONTENT, % DRY WEIGHT	116.10	98.70	-	83.64	84.31	-	77.77	77.73	-	71.51	64.73	-	62.45	63.01	-	57.77	61.03	-	62.45	60.86	-
VOID RATIO DETERMINED IN LAB.	3.46	2.789	-	2.546	2.367	-	-	-	-	2.048	1.933	-	1.762	1.766	-	1.625	1.708	-	1.725	-	-
AT 100% SATURATION	3.26	2.743	-	2.463	2.312	-	2.51	2.163	-	2.609	1.782	-	1.732	1.749	-	1.600	1.702	-	1.727	1.685	-
POROSITY, %	77.0	73.6	-	71.9	70.3	-	63.5	63.8	-	57.3	61.2	-	63.3	63.8	-	61.9	63.1	-	63.8	63.3	-
SATURATION, %	97.0	60.3	-	94.4	63.2	-	98.5	93.1	-	98.3	93.3	-	90.3	99.0	-	98.5	99.7	-	100	97.7	-
Liquid Limit	68	67	-	67	67	-	67	57	-	55	55	-	62	64	-	62	64	-	64	64	-
PLASTIC LIMIT	-	-	-	28	23	-	27	25	-	25	25	-	25	25	-	26	26	-	26	26	-
Liquidity Index, %	22.0	17.7	-	16.8	14.4	-	12.7	12.1	-	14.6	12.4	-	12.5	12.7	-	8.8	9.7	-	9.6	9.2	-
PLASTICITY INDEX	1.40	-	-	1.39	-	-	1.40	-	-	1.32	-	-	1.30	-	-	0.47	-	-	0.41	0.49	-
COMPRESSION INDEX FROM LL	0.52	-	-	0.53	-	0.51	-	-	-	0.42	-	-	0.41	-	-	-	-	-	-	-	-
COMPRESSION INDEX FROM LL FROM e109 P	-	-	-	-	-	0.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	21.5	1.43	-	0.46	0	-	0.72	-	0	0	-	0.15	0.20	-	0	0	-	0	0	-	-
COMPRESSIVE UNDISTRESSED STRENGTH, REINOLVED, PSI	0.28	-	-	0.60	0.60	-	0.76	-	1.14	0.98	-	1.40	1.33	-	1.58	1.82	-	1.82	-	-	
DEMOLOND SENSITIVITY	-	-	-	0.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, PSI	-	-	-	1.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, g cm ⁻²	-	0.13	-	0.30	0.32	-	0.23	-	0.57	0.49	-	0.70	0.53	-	0.78	0.91	-	0.91	-	-	
ACTIVITY	-	-	-	9.1	-	21.1	21.1	-	26.7	-	40.1	34.5	-	49.2	48.5	-	55.5	64.0	-	64.0	-
MODULUS OF ELASTICITY, PSI	-	-	-	0.93	0.85	-	0.92	-	0.96	-	15.3	15.2	-	19.8	24.6	-	23.6	-	-	25.4	-
GRAIN MEDIAN DIA. phi, microns	-	4.3	-	8.8	6.6	-	8.8	-	8.9	-	15.3	15.2	-	19.8	24.6	-	23.6	-	-	25.4	-
SAID, % > 504 < 2 mm	-	6.3	-	6.2	5.2	-	3.4	-	3.2	-	7.0	7.0	-	6.5	7.6	-	8.6	-	-	8.6	-
SILT, % > 2 & < 0.064	6	3.2	-	5	-	5	-	5	-	15	-	15	-	17	-	17	-	17	-	2.6	-
CLAY, % < 0.064	51	4.0	-	53	4.6	-	48	-	51	-	51	-	51	-	51	-	51	-	48	-	
SEDIMENT TYPE	-	4.3	-	4.3	4.6	-	3.2	-	3.7	-	32	-	32	-	Clayey-Silt						
Mica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kaolinite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Montmorillonite-mica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other Minerals	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcite, % entire sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quartz, % entire sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AREA A CORE 33

CRUISE: 1958. SONIC DEPTH, UNCORRECTED, 580 fms. CORER, 400 lb. Gravity Kullenberg

APPROX. CORER PENETRATION: 60 in. CORE: 38 in. LONG. DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	
WET UNIT WEIGHT g/cm ³	1.67-3	1.37	1.39	-	1.45	1.43	-	1.45	1.45	-	1.44	1.44	-	1.46	1.47	-	1.50	-	
SPECIFIC GRAVITY OF SOLIDS	2.388	2.309	-	2.785	2.783	-	2.785	2.309	-	2.791	2.798	-	2.838	2.774	-	2.790	2.816	-	
WATER CONTENT, % DRY WEIGHT	15.07	12.854	-	104.92	108.29	-	98.46	99.43	-	101.44	100.93	-	96.41	92.95	-	89.55	86.87	-	
VOID RATIO DETERMINED IN LAB.	3.806	3.454	-	3.012	3.065	-	2.916	3.061	-	2.898	2.889	-	2.767	2.630	-	2.533	2.977	-	
VOID RATIO AT 100% SATURATION	3.793	3.386	-	2.929	3.016	-	2.746	2.793	-	2.831	2.884	-	2.692	2.278	-	2.498	2.446	-	
DENSITY, %	79.2	77.5	-	75.1	75.4	-	73.8	74.1	-	74.3	74.3	-	73.4	72.5	-	71.7	71.4	-	
SATURATION, %	99.0	-	97.1	98.4	-	97.5	97.6	-	97.7	97.8	-	97.7	98.0	-	98.6	98.0	-		
Liquid Limit	94	79	-	76	76	-	76	83	-	81	77	-	77	77	-	77	77	-	
Plastic Limit	30	30	-	30	30	-	30	31	-	30	30	-	30	30	-	30	30	-	
Liquidity Index, %	194	168	-	153	159	-	149	151	-	135	134	-	130	123	-	127	121	-	
Plasticity Index	54	-	19	-	46	-	52	-	52	-	52	-	52	-	47	-	-	-	
COMPRESSION INDEX FROM LL	0.66	-	0.62	-	0.59	-	0.66	-	0.66	-	0.64	-	0.64	-	0.66	-	-	-	
COMPRESSION INDEX FROM E ₀₉ P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SLING %	2.05	0.67	-	0	0	-	0	0.10	-	0	0.10	-	0	0.10	-	0.21	0.50	-	
COMPRESSIVE UNDISTURBED PSI REMOULDED, PSI	0.21	0.26	-	0.34	0.38	-	0.44	0.53	-	0.65	0.61	-	0.73	0.75	-	0.82	0.83	-	
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION PSI	0.11	0.13	-	0.17	0.19	-	0.22	0.29	-	0.38	0.31	-	0.39	0.38	-	0.41	0.42	-	
ACTIVITY	0.77	0.91	-	12.0	13.4	-	15.5	20.4	-	26.7	21.8	-	27.4	26.7	-	28.8	29.5	-	
MODULUS OF ELASTICITY, PSI	2.4	3.9	-	5.0	5.0	-	9.7	22.3	-	8.0	0.98	-	1.00	-	-	0.02	-	-	
GRAIN MEDIAN DIA., PHI	-	9.2	9.3	-	9.1	9.1	-	9.1	9.3	-	9.1	9.1	-	9.1	9.1	-	9.1	-	-
SAND, % > 60μ < 2mm	-	1.7	1.6	-	2	2	-	1.9	1.6	-	4	1.6	-	1.9	1.9	-	1.9	-	-
SILT, % > 2μ < 60μ	45	43	-	46	46	-	46	46	-	43	43	-	44	44	-	5	5	-	-
CLAY, % < 2μ	53	55	-	51	51	-	53	53	-	51	51	-	51	51	-	51	51	-	-
Sediment Type	Slidy Clay	Silty Clay	-	Slidy Clay	Silky Clay	-	Slidy Clay	Silky Clay	-	Slidy Clay	Silky Clay	-	Slidy Clay	Silky Clay	-	Slidy Clay	Slidy Clay	-	-
Mica	-	-	-	40	-	-	-	-	-	-	-	-	-	-	-	40	-	-	-
Kaolinite	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
Montmorillonite-andesite	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-
Calcite	-	-	-	5-10	-	-	-	-	-	-	-	-	-	-	-	5-10	-	-	-
Other minerals	-	-	-	15-20	-	-	-	-	-	-	-	-	-	-	-	15-20	-	-	-
Calcare, % entire sample	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-
Quartz, % entire sample	-	-	-	26	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-

AREA B CORE 83

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 720 fms. COREID: 150 lb. Gravity Kullenberg

APPROX. CORE PENETRATION: TO IN. CORE: LENGTH, LONG. DIA.M. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36
WET UNIT WEIGHT, g/cm ⁻³	1.6 ft ⁻³	93.7	95.9	-	99.0	100.8	104.3	102.4	-	103.5	104.5	-	105.7	104.7	-	105.4	-	107.6
SPECIFIC GRAVITY OF SOLIDS	2.758	2.807	-	2.815	2.830	2.836	2.792	2.822	-	2.807	2.805	-	2.830	2.804	-	2.784	-	2.794
WATER CONTENT, % DRY WEIGHT DETERMINED IN LAB.	84.13	86.03	-	69.24	66.11	59.64	60.46	62.32	-	57.74	55.73	-	53.90	54.52	-	52.94	-	52.36
VOID RATIO AT 100% SATURATION	2.394	2.246	-	1.969	1.691	1.673	1.883	1.801	-	1.732	1.801	-	1.667	1.631	-	1.545	1.584	-
FORPOROSITY, %	70.8	69.6	-	66.8	65.3	62.7	63.4	64.3	-	62.5	61.7	-	60.7	61.3	-	60.3	-	59.5
SATURATION, %	97.1	98.1	-	97.9	98.4	99.6	97.5	97.6	-	97.2	97.0	-	97.7	96.5	-	97.0	-	99.6
LIQUID LIMIT	58	57	-	57	53	-	53	-	-	54	53	-	54	53	-	54	51	52
PLASTIC LIMIT	35	34	-	31	31	-	28	29	-	30	30	-	30	29	-	31	29	28
LIQUIDITY INDEX, %	21.3	20.0	-	24.6	15.9	-	128	118	-	117	113	-	96	104	-	96	-	100
PLASTICITY INDEX	23	23	-	26	22	-	25	28	-	24	23	-	25	23	-	23	22	24
COMPRESSIVE INDEX FROM LL	0.43	0.42	-	0.42	0.39	-	0.39	0.42	-	0.40	0.39	-	0.40	0.39	-	0.40	0.37	0.38
COMPRESSIVE INDEX FROM e-log P	-	-	-	-	0.35	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	6.21	3.87	-	1.64	-	-	1.04	0.99	-	0.84	0.84	-	0	0	-	-	-	0
COMPRESSIVE "UNDISTURBED" PSI STRENGTH, REINOLDED, PSI	0.68	0.65	-	1.08	1.15	-	2.12	1.67	-	2.65	2.35	-	3.70	6.65	Vertical crack in sample	-	-	2.95
REMOLDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, PSI	0.34	0.33	-	0.34	0.39	-	1.06	0.84	-	1.33	1.18	-	1.85	3.33	Vertical crack in sample	-	-	1.48
ACTIVITY	23.9	23.2	-	37.9	41.5	-	74.5	59.0	-	93.5	83.0	-	130.0	234.1	-	-	-	104.0
MODULUS OF ELASTICITY, PSI	4.4	5.4	-	9.1	11.12	-	21.2	22.4	-	27.5	46.6	-	0.50	0.51	0.45	-	-	-
GRAIN MEDIAN DIA. (MICRONS)	phi	8.8	-	8.6	8.3	-	3.2	3.2	-	8.6	8.8	-	80.0	104.7	Vertical creek in sample	8.0	8.0	37.2
SAND, % > 60μ < 2mm	8	2.3	-	2.5	-	-	-	-	-	2.5	-	-	2.3	-	-	2.1	-	-
SLIT, % > 2μ < 60μ	45	47	-	7	-	-	-	-	-	4	-	-	14	-	-	11	-	-
CLAY, % < 2μ	45	47	-	53	-	-	50	37	-	46	40	-	49	-	-	49	-	-
SEDIMENT TYPE	Silt	Clay	-	43	-	-	Clayey Silt	Clayey Silt	-	Clayey Silt	Clayey Silt	-	Silt	Clay	-	-	-	-

AREA B CORE 85

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 4004 ms. CORER: 460 lb. Gravity Kullenberg

APPROX. CORER PENETRATION: 72 IN. CORE: 31 in. LONG, DIAM. 1.375 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30
WET UNIT WEIGHT g/cm ³	1.47 ± 3	90.6	93.0	-	94.6	94.5	-	97.5	100.6	-	102.9	103.3	-	106.0	104.8
SPECIFIC GRAVITY OF SOLIDS	2.706	2.721	-	2.785	2.773	-	2.794	2.757	-	1.56	1.65	-	1.70	1.68	-
WATER CONTENT, % DRY WEIGHT	95.03	84.39	-	82.56	83.12	-	73.46	63.56	-	58.46	57.20	-	51.97	51.32	-
VOID RATIO DETERMINED IN LAB.	2.759	2.448	-	2.356	2.344	-	2.106	1.786	-	1.667	1.632	-	1.481	1.494	-
AT 100% SATURATION	2.657	2.355	-	2.299	2.305	-	2.053	1.752	-	1.622	1.595	-	1.441	1.427	-
POROSITY, %	73.4	71.0	-	70.2	70.1	-	67.3	64.1	-	62.5	62.0	-	59.7	59.9	-
SATURATION, %	96.3	96.2	-	97.6	98.3	-	97.5	98.1	-	97.3	97.1	-	97.3	95.5	-
LIMITS	69	64	-	55	55	-	55	55	-	52	52	-	52	52	-
PLASTIC LIMIT	23	-	-	26	-	-	26	-	-	25	-	-	26	-	-
LIQUIDITY INDEX, %	163	137	-	149	150	-	164	129	-	124	119	-	100	97	-
PLASTICITY INDEX	41	-	-	33	-	-	29	-	-	27	-	-	26	-	-
COMPRESSION INDEX	0.53	-	-	0.49	-	-	0.41	-	-	0.37	-	-	0.37	-	-
FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FROM e-log P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	C	0.21	-	1.55	2	-	2	-	-	2	-	-	2	0	-
COMPRESSIVE "UNDISTURBED" PSI	0.57	0.53	-	0.23	0.66	-	1.37	1.60	-	2.19	2.32	-	2.85	2.55	-
STRENGTH REMOLDED, PSI	-	-	-	-	-	-	-	0.71	-	-	-	-	-	0.37	-
DEMOLDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	2.9	-
COHESION PSI	0.29	0.37	-	0.32	0.33	-	0.39	0.30	-	1.20	1.15	-	1.43	1.26	-
COHESION g/m ⁻²	20.4	12.5	-	22.5	23.2	-	41.5	56.3	-	31.4	31.6	-	120.5	90.0	-
ACTIVITY	-	-	-	0.32	-	-	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	14.9	14.0	-	6.3	21.3	-	19.7	26.4	-	31.3	35.0	-	34.9	28.6	-
GRAIN MEDIAN DIA. mm	9.0	3.7	-	3.7	8.4	-	8.4	3.4	-	3.5	3.5	-	9.0	3.8	-
SAND, % > 60μ < 2 mm	2.0	-	-	2.4	-	-	2.9	-	-	-	-	-	-	-	-
SILT, % > 2 μ < 60 μ	48	-	-	4	-	-	3	-	-	4	-	-	2	-	-
CLAY, % < 2 μ	50	46	-	50	51	-	52	53	-	56	56	-	42	42	-
SEDIMENT TYPE	Clayey Silt	Clayey Silt	-	Clayey Silt	Clayey Silt	-	Clayey Silt	Clayey Silt	-	Clayey Silt	Clayey Silt	-	Clayey Silt	Clayey Silt	-

AREA B CORE 87

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 620 fms. CORER: 150 lb. Gravity Kullenberg
 APPROX. COER PENETRATION: 72 IN. CORE: 32 IN. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30
WET UNIT WEIGHT lb/ft ³	94.0	98.6	102.5	101.3	-	103.9	103.9	-	105.9	104.8	-	103.5	103.8	-	-
WET UNIT WEIGHT gm/cm ³	1.51	1.56	1.63	1.62	-	1.66	1.66	-	1.70	1.67	-	1.66	1.65	-	-
SPECIFIC GRAVITY OF SOLIDS	2.615	2.616	2.617	2.617	-	2.614	2.616	-	2.619	2.616	-	2.613	2.614	-	-
WATER CONTENT, % DRY WEIGHT	64.19	64.09	64.19	64.09	-	64.19	64.09	-	64.51	64.51	-	64.56	64.93	-	-
VOID RATIO DETERMINED IN LAB	2.434	2.097	1.883	1.869	-	1.607	1.603	-	1.583	1.583	-	1.653	1.672	-	-
POOROSITY AT 100% SATURATION	2.359	2.097	1.866	1.855	-	1.594	1.592	-	1.525	1.525	-	1.633	1.640	-	-
POROSITY, %	70.9	67.1	64.6	64.1	-	63.6	61.6	-	60.5	61.1	-	62.3	62.6	-	-
SATURATION, %	96.9	100.1	99.1	98.3	-	99.3	97.6	-	99.1	96.6	-	97.8	97.9	-	-
Liquid Limit	59	57	51	50	-	54	59	-	59	59	-	60	60	-	-
PLASTIC LIMIT	32	30	29	29	-	23	26	-	26	26	-	28	28	-	-
LIQUIDITY INDEX, %	192	167	128	126	-	113	106	-	86	88	-	94	97	-	-
PLASTICITY INDEX	27	27	27	27	-	31	31	-	33	33	-	32	32	-	-
COMPRESSION INDEX FROM LL FROM S109 P	0.14	-	0.13	-	0.10	-	0.10	-	0.40	0.41	-	0.45	-	-	-
SUMM. %	-	-	-	-	-	-	-	-	0.37	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED" PSI STRENGTH REMOLOED, PSI	0.44	0.25	0	0.16	-	0	0	-	-	0.16	-	0.15	0.10	-	-
REMOULDING SENSITIVITY	0.73	1.32	-	1.51	1.97	-	2.55	2.38	-	2.75	-	2.34	2.20	-	-
COHESION g/cm ²	-	-	-	-	-	-	0.84	-	-	-	-	-	-	-	-
ACTIVITY	0.37	0.61	-	0.76	0.93	-	1.23	1.19	-	-	1.38	-	1.17	1.10	-
MODULUS OF ELASTICITY, PSI	26.0	24.9	-	53.4	60.6	-	90.0	83.7	-	97.0	-	82.3	77.3	-	-
GRAIN MEDIAN DIA. phi	19.6	9.0	-	17.3	26.0	-	24.0	25.5	-	49.1	-	32.6	25.4	-	-
SAND, % > 2.0 mm	3.7	8.2	-	2.3	2.5	-	8.3	8.3	-	8.6	-	8.9	-	-	-
SILT, % > 2.0-6.0 mm	8	7	-	7	7	-	3.2	3.2	-	4	-	2.9	2.1	-	-
CLAY, % < 2.0 mm	45	47	-	47	53	-	53	50	-	50	-	33	33	-	-
SEDIMENT TYPE	SILTY CLAY	SILTY CLAY	-	CLAYEY SILT	CLAYEY SILT	-	CLAYEY SILT	CLAYEY SILT	-	CLAYEY SILT	-	CLAYEY SILT	CLAYEY SILT	-	-
Minerals	-	-	-	-	-	lo	-	-	-	-	-	-	-	lo	-
Kalcite	-	-	-	-	-	20	-	-	-	-	-	-	-	20	-
Montmorillonite-micah	-	-	-	-	-	5-10	-	-	-	-	-	-	-	5-10	-
Calcite	-	-	-	-	-	10-15	-	-	-	-	-	-	-	10-15	-
Other minerals	-	-	-	-	-	35	-	-	-	-	-	-	-	35	-
Caclite, ¹ entire sample	-	-	-	-	-	15	-	-	-	-	-	-	-	15	-
Quartz, ² entire sample	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AREA C CORE 16

CRUISE: 1958 SONIC DEPTH, UNCORRECTED: 610 fms. CORER: 350lb. Piston Kullenberg

APPROX. CORER PENETRATION: 70 IN. CORE: 31 in. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30
WET UNIT WEIGHT lb ft^{-3} g cm^{-3}	107.8	104.9	-	102.1	103.4	-	105.5	106.6	-	107.3	108.8	-	106.8	105.8	-
SPECIFIC GRAVITY OF SOLIDS	1.72	1.68	-	1.63	1.66	-	1.69	1.71	-	1.72	1.74	-	1.71	1.69	-
WATER CONTENT, % DRY WEIGHT	2.770	2.818	-	2.819	2.811	-	2.847	2.856	-	2.826	2.822	-	2.822	2.831	-
VOID RATIO DETERMINED IN LAB.	41.6	55.7	-	61.4	57.0	-	54.0	51.4	-	50.7	46.6	-	53.97	54.23	-
POROSITY AT 100% SATURATION	1.52	1.570	-	1.731	1.602	-	1.591	1.532	-	1.481	1.358	-	1.506	1.575	-
POROSITY, %	56.0	61.7	-	64.0	62.5	-	61.4	60.5	-	59.7	57.5	-	60.1	61.2	-
SATURATION, %	90.5	97.4	-	97.3	96.1	-	96.6	95.8	-	96.8	96.2	-	97.4	97.5	-
Liquid Limit	46	-	54	-	-	45	-	41	-	42	-	-	-	-	-
Plastic Limit	20	-	21	-	19	-	17	-	18	-	-	-	-	-	-
Liquidity Index, %	83	137	-	122	106	-	135	125	-	140	123	-	141	151	-
PLASTICITY INDEX	26	-	33	-	30	-	26	-	24	-	24	-	24	-	-
COMPRESSION INDEX FROM LL	0.32	-	0.40	-	0.32	-	0.28	-	0.28	-	0.29	-	0.29	-	-
COMPRESSION INDEX FROM e-109 P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	1.03	0.26	-	0.26	0	-	0.26	0.52	-	0	0.26	-	0	0	-
COMPRESSIVE STRENGTH "UNDISTURBED", PSI	1.06	1.34	-	1.32	1.15	-	1.90	1.24	-	1.47	2.29	-	-	1.37	-
REMOLEDO, PSI	-	-	-	0.37	-	-	-	-	-	0.68	-	-	-	-	-
REMOULDING SENSITIVITY	-	-	-	-	3.1	-	-	-	-	-	3.4	-	-	-	-
COHESION PSI	0.53	0.67	-	0.66	0.58	-	0.95	0.62	-	0.74	1.25	-	-	0.60	-
ACTIVITY	37.3	47.1	-	46.4	40.7	-	66.8	53.6	-	52.0	30.8	-	-	48.5	-
MODULUS OF ELASTICITY, PSI	0.76	-	0.96	-	0.94	-	0.84	-	-	-	-	-	-	0.86	-
GRAIN MEDIAN DIA. microns	18.0	12.4	-	22.9	15.8	-	25.4	16.4	-	16.4	36.3	-	-	17.3	-
SAND, % > 60 < 2 mm	6.8	-	-	6.9	6.2	-	6.3	6.0	-	6.0	-	-	-	6.1	-
SILT, % > 2 < 60 μ	9.0	-	-	8.0	7.0	-	12.9	11.1	-	15.6	-	-	-	14.3	-
CLAY, % < 2 μ	43	23	-	16	11	-	24	20	-	24	20	-	-	20	-
SEDIMENT TYPE	34	-	49	-	58	-	49	52	-	27	27	-	-	28	-
	Sand-Silt-Clay	Clayey Silt		Clayey Silt	Sand-Silt-Clay		Clayey Silt	Sand-Silt-Clay		Clayey Silt	Sand-Silt-Clay		-	Clayey Silt	

AREA C CORE 18

CRUISE: 1958 SONIC DEPTH, UNCORRECTED; 610 fms. CORER: 350 lb. Piston Kullenberg

APPROX. CORER PENETRATION: 66 IN. CORE: 46 IN. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
DISTANCE FROM TOP OF CORE, in	0.2	2.4	4.6	6.8	9.30	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40	40-42
WET UNIT WEIGHT, lb./ft. ³	100.1	98.9	-	103.1	105.0	-	107.2	105.3	-	101.4	106.3	-	101.6	99.7	-	96.8	95.6	-	98.6	103.5	-
SPECIFIC GRAVITY OF SOLIDS	1.65	1.63	-	1.72	1.69	-	1.72	1.69	-	1.67	1.70	-	1.63	1.60	-	1.55	1.53	-	1.53	1.66	-
WATER CONTENT, % DRY WEIGHT	2.83	2.82	-	2.83	2.816	-	2.35	2.050	-	2.317	2.017	-	2.813	2.817	-	2.823	2.814	-	2.86	2.82	-
VOID RATIO DETERMINED IN LAB.	64.31	72.21	-	61.45	57.53	-	51.21	45.11	-	56.96	53.20	-	66.10	67.02	-	77.18	79.55	-	74.93	75.95	-
AT 100-% SATURATION	1.87	2.057	-	1.72	1.667	-	1.252	1.468	-	1.683	1.533	-	1.922	1.922	-	2.224	2.293	-	2.117	1.671	-
POROSITY, %	55.2	56.36	-	51.73	51.35	-	51.45	51.34	-	51.605	51.499	-	51.859	51.664	-	51.179	52.238	-	51.110	51.638	-
SATURATION, %	56.3	58.7	-	63.8	52.5	-	60.3	59.5	-	62.2	50.5	-	63.2	56.1	-	69.0	69.7	-	67.9	62.6	-
Liquid Limit	19	30	-	98.6	30.2	-	96.9	89.5	-	97.7	97.8	-	99.4	97.0	-	98.0	97.4	-	99.7	96.8	-
PLASTIC LIMIT	19	45	-	42	18	-	42	18	-	47	19	-	57	22	-	59	24	-	59	20	-
Liquidity Index, %	153	180	-	163	148	-	140	117	-	136	122	-	126	129	-	152	159	-	239	163	-
PLASTICITY INDEX	29	-	26	-	24	-	24	-	28	-	35	-	35	-	35	-	35	-	35	-	33
COMPRESSION INDEX FROM LL	0.35	-	0.31	-	0.29	-	0.33	-	0.33	-	0.42	-	0.42	-	0.42	-	0.44	-	0.44	-	0.30
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE STRENGTH UNDISTURBED, PSI	0.41	2.74	-	0.21	0	-	0.26	1.93	-	0.41	-	-	0.10	-	-	1.39	1.81	-	0.52	0	-
REMOLEOSED, PSI	1.32	0.79	-	1.33	1.08	-	1.50	1.51	-	1.08	2.14	-	1.27	-	-	0.76	0.62	-	0.94	1.60	-
REMOLEOSED SENSITIVITY	-	-	-	-	-	-	-	0.88	-	-	-	-	-	-	-	0.31	-	-	-	-	-
COHESION, PSI	0.66	0.40	-	0.67	0.54	-	0.60	0.76	-	0.54	1.07	-	0.64	-	-	2.0	-	-	-	-	-
ACTIVITY	36.4	28.1	-	47.1	38.0	-	56.2	53.4	-	38.0	75.2	-	35.0	-	-	26.7	56.2	-	33.0	56.2	-
MODULUS OF ELASTICITY, PSI	9.4	-	1.11	1.04	-	0.92	-	0.92	-	0.87	-	-	0.85	-	-	0.83	-	-	0.79	-	-
GRAIN MEDIAN DIA., MM.	5.9	-	16.8	10.2	-	13.0	22.1	-	15.1	20.5	-	-	35.0	-	-	6.4	6.3	-	7.6	15.2	-
SAND, % > 2.00 < 2.00 mm.	16.7	-	12.5	12.5	-	16.0	-	6.0	-	6.0	-	-	7.7	-	-	8.1	-	-	6.4	-	-
SILT, % > 2.00 < 0.02 mm.	30	-	18	-	18	-	15.6	8.8	-	8.8	-	-	4.7	-	-	3.6	-	-	11.8	-	-
CLAY, % < 0.02 mm.	44	-	37	-	26	-	26	-	18	-	14	-	6	-	-	5.6	-	-	5.6	-	-
SEDIMENT TYPE	Sand-Silt-Clay	-	Clayey-silt	-	Clayey-silt	-	Clayey-silt	-	Clayey-silt	-	Clayey-silt	-	Clayey-silt	-	-	Clayey-silt	-	-	Clayey-silt	-	-
Mica	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Kaolinite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Montmorillonite-smectite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chlorite	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quartz and Feldspar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

CLAY
SIZE

mm

AREA C CORE 19

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 800 fms. CORER: 350 lb. Piston Kullenberg
 APPROX. CORER PENETRATION: 48 in. CORE: 20 in. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28
WET UNIT WEIGHT lb ft ⁻³ gcm ⁻³	81.5	80.2	-	84.7	87.2	-	84.1	86.2	-	106.1	101.2	-	105.0	-
SPECIFIC GRAVITY OF SOLIDS	2.776	2.805	-	2.802	2.839	-	2.812	1.38	-	1.70	1.62	-	1.68	-
WATER CONTENT, % DRY WEIGHT	161.69	177.35	-	137.36	120.49	-	140.23	23.75	-	53.07	62.19	-	53.22	-
VOID RATIO DETERMINED IN LAB. AT 100% SATURATION	4.568	5.052	-	3.900	3.460	-	4.018	3.592	-	1.522	1.812	-	1.552	-
POROSITY, %	82.0	83.5	-	3.819	3.421	-	3.946	3.517	-	1.486	1.747	-	1.495	-
SATURATION, %	98.3	97.5	-	98.7	98.3	-	98.2	97.9	-	97.6	96.4	-	96.4	-
LIQUID LIMIT	89	-	85	-	-	49	-	-	48	-	-	-	-	58
PLASTIC LIMIT	33	-	32	-	-	24	-	-	20	-	-	-	-	21
LIQUIDITY INDEX, %	230	258	-	199	167	-	483	400	-	118	151	-	87	-
PLASTICITY INDEX	56	-	53	-	-	25	-	-	28	-	-	-	-	37
COMPRESSION INDEX FROM LL	0.71	-	0.68	-	-	0.35	-	-	0.34	-	-	-	-	0.43
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED" PSI STRENGTH REMOLED, PSI	0.18	0.28	-	0.07	1.81	-	2.58	4.75	-	3.87	1.55	-	0	-
REMOULDING SENSITIVITY	-	-	-	0.28	1.37	-	0.26	0.35	-	0.88	0.80	-	2.08	-
COHESION PSI gcm ⁻²	0.09	0.14	-	0.29	0.69	-	0.29	0.18	-	0.44	0.40	-	0.96	-
ACTIVITY	6.3	9.8	-	20.4	48.5	-	20.1	12.6	-	30.9	28.1	-	73.1	-
MODULUS OF ELASTICITY, PSI GRAN MEDIAN DIA. microns	-	1.8	-	4.7	10.0	-	3.9	2.2	-	5.1	4.6	-	39.3	-
SAND, % > 60μ < 2 mm	5.8	-	-	-	7.1	-	5.8	-	-	6.1	-	-	7.3	-
SILT, % > 2 μ < 60 μ	7	-	-	-	-	5	-	-	17.5	-	-	14.3	-	
CLAY, % < 2 μ	60	-	-	-	-	61	-	-	20	-	-	17	-	
SEDIMENT TYPE	33	-	Clayey Silt	34	-	-	-	-	56	-	-	51	-	
			Clayey Silt			-	-	-	24	-	-	27	-	
			Clayey Silt			-	-	-	-	-	-	Clayey Silt	-	

AREA C CORE 20

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 880 fms. CORER: 350 lb. Piston
Kullenberg APPROX. CORER PENETRATION: 48 IN. CORE: 22 IN. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18
WET UNIT WEIGHT g/cm ³	1b ft ⁻³	80.2	81.0	-	84.6	87.5	-	99.7	95.0
SPECIFIC GRAVITY OF SOLIDS		1.28	1.30	-	1.35	1.40	-	1.60	1.52
WATER CONTENT, % DRY WEIGHT		2.786	2.815	-	2.831	2.813	-	2.767	2.846
VOID RATIO	DETERMINED IN LAB.	173.57	171.93	-	142.02	118.87	-	78.70	88.97
	AT 100% SATURATION	4.917	4.882	-	4.051	3.386	-	2.532	-
POROSITY, %		4.836	4.840	-	4.021	3.344	-	2.178	2.532
SATURATION, %		83.1	83.0	-	80.2	77.2	-	68.2	71.7
LIQUID LIMIT		98.3	99.1	-	99.2	98.7	-	100	100
PLASTIC LIMIT			89	-		68	-		54
LIQUIDITY INDEX, %			36	-		29	-		25
PLASTICITY INDEX		260	256	-	290	230	-	185	221
COMPRESSION INDEX	FROM LL		0.71			0.52			0.40
	FROM e-log p		-	-	-	-	-	0.60	-
SLUMP, %		-	2.07	-	1.29	-	-	-	1.70
COMPRESSIVE STRENGTH	"UNDISTURBED", PSI		0.31	-	0.79	0.79	-	-	0.73
	REMOLDED, PSI		-	-	-	0.26	-	-	-
REMOULDING SENSITIVITY		-	-	-	-	3.0	-	-	-
COHESION	PSI	-	0.16	-	0.40	0.40	-	-	0.37
	g/cm ⁻²	-	11.2	-	28.1	28.1	-	-	26.0
ACTIVITY		-		1.51			1.39		1.07
MODULUS OF ELASTICITY, PSI		-	-	-	-	-	-	-	4.5
GRAIN MEDIAN DIA.	Phi		7.7			4.4			6.2
	microns		4.9			11.4			13.6
SAND, % > 60μ < 2 mm			13			17			7
SILT, % > 2 μ < 60 μ			52			55			66
CLAY, % < 2 μ			35			28			27
SEDIMENT TYPE	Clayey	Silt			Clayey	Silt		Clayey	Silt
Clay-size fract. φ < Z μ only	Mica	-	-	-	20	-	-	-	-
	Kaolinite	-	-	-	10	-	-	-	-
	Montmorillonite-mica	-	-	-	50	-	-	-	-
	Chlorite	-	-	-	10	-	-	-	-
	Quartz and Feldspar	-	-	-	10	-	-	-	-

AREA D CORE 1g

CRUISE: 1958 SONIC DEPTH, UNCORRECTED: 680 fms. CORER: 80 lb.
Gravity Phleger
APPROX. CORER PENETRATION: 30 IN. CORE: 18 in. LONG, DIAM. 1.37 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16
WET UNIT WEIGHT	lb ft ⁻³ g cm ⁻³	90.7 1.45	93.0 1.49	94.2 1.51	94.1 1.51	96.2 1.54	95.6 1.53	96.0 1.54
SPECIFIC GRAVITY OF SOLIDS	2.854	2.841	2.842	2.833	2.845	2.818	2.825	-
WATER CONTENT, % DRY WEIGHT	107.77	92.99	89.49	88.55	81.40	83.45	82.90	-
VOID RATIO	DETERMINED IN LAB.	3.083	2.663	2.568	2.546	2.350	2.376	2.361
	AT 100 % SATURATION	3.076	2.641	2.543	2.510	2.316	2.352	2.342
POROSITY, %		75.5	72.7	72.0	71.8	70.1	70.4	70.4
SATURATION %		99.8	99.2	99.0	98.6	98.9	99.0	99.2
LIQUID LIMIT		35.3		38.7		36.5		38.2
PLASTIC LIMIT		32.0		37.1		32.7		33.2
LIQUIDITY INDEX, %		1994	1605	3274	3216	1281	1335	994
PLASTICITY INDEX		3.8		1.6		3.8		5.0
COMPRESSION INDEX	FROM LL	0.23		0.26		0.24		0.25
	FROM e-log p							
SLUMP, %		1.28	0	0.49	0.74	0.29	0	0.74
COMPRESSIVE STRENGTH	"UNDISTURBED", PSI	1.58	3.22	2.78	4.49	4.93	4.31	5.92
	REMOLDED, PSI	-	-	-	-	-	-	-
REMOLDING SENSITIVITY		-	-	-	-	-	-	-
COHESION	PSI	0.79	1.61	1.39	2.25	2.47	2.16	2.96
	g cm ⁻²	55.5	113.2	97.7	158.2	173.6	151.9	208.1
ACTIVITY		0.15		0.06		0.14		0.17
MODULUS OF ELASTICITY, PSI		16.9	42.2	28.2	48.7	43.7	36.6	65.9
GRAIN MEDIAN DIA.	Phi	5.4		5.5		5.5		5.6
	microns	23.4		22.1		22.1		20.6
SAND, % > 60μ< 2mm		21		19		16		17
SILT, % > 2μ< 60μ		53		52		56		54
CLAY, % < 2μ		26		29		23		29
SEDIMENT TYPE		Send-silt-clay	Clayey-silt	Clayey-silt	Clayey-silt	Clayey-silt		

AREA D CORE 2

CRUISE: 1958. SONIC DEPTH, UNCORRECTED: 1100 fms. CORER: 80 lb.
APPROX. CORER PENETRATION: 36 in. CORE: 12 in. LONG, DIAM. 1.37 in.

SAMPLE NUMBER		1	2	3	4	5		
DISTANCE FROM TOP OF CORE, in		0-2	2-4	4-6	6-8	8-9		
WET UNIT WEIGHT	lb ft ⁻³ g cm ⁻³	93.2 1.49	98.1 1.57	99.0 1.59	95.8 1.53	-		
SPECIFIC GRAVITY OF SOLIDS		2.801	2.809	2.818	2.797	-		
WATER CONTENT, % DRY WEIGHT		91.13	76.59	71.23	77.66	-		
VOID RATIO	DETERMINED IN LAB.	2.507	2.357	2.042	2.240	-		
	AT 100% SATURATION	2.553	2.151	2.007	2.172	-		
POROSITY, %		72.1	68.3	67.1	69.1	-		
SATURATION, %		98.7	99.7	98.3	97.0	-		
LIQUID LIMIT		51.4			44.9			
PLASTIC LIMIT		40.4			38.6			
LIQUIDITY INDEX, %		1268	905	518	620	-		
PLASTICITY INDEX		11.0			6.3			
COMPRESSION INDEX	FROM LL	0.37			0.3			
	FROM e-109 p	-	-	-	-	-		
SLUMP, %		2.75	0.20	0	0	-		
COMPRESSIVE STRENGTH	"UNDISTURBED", PSI REMOLDED, PSI	0.88	2.75	3.29	3.37	-		
REMOLDING SENSITIVITY		-	-	-	-	-		
COHESION	PSI g cm ⁻²	0.44 30.9	1.30 97.0	1.05 116.0	1.69 118.8	-		
ACTIVITY		0.11			0.29			
MODULUS OF ELASTICITY, PSI		7.6	22.9	33.3	56.2	-		
GRAIN MEDIAN DIA.	phi microns	5.9 16.5			5.5 22.1			
SAND, % > 60μ < 2 mm		2.3			33			
SILT, % > 2 μ < 60 μ		4.2			45			
CLAY, % < 2 μ		3.5			22			
SEDIMENT TYPE		Sand - Silt - Clay						

AREA D CORE 1^a

1959. SONIC DEPTH, UNCORRECTED, 1400 fms. CORER, 1200 lb. Piston Boring

CRUISE: APPROX. CORER PENETRATION: 240 IN. COREL: 201 in. LONG, DIAM.

2.5 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
DISTANCE FROM TOP OF CORE, in	0 -	4.5 -	9 -	15.5 -	20.0 -	24.5 -	31 -	35.5 -	40 -	46.5 -	51 -	55.5 -	60.5 -	65.5 -	70.5 -	75.5 -	80.5 -	85.5 -	90.5 -	95.5 -	100.5 -	105.5 -
1 ft = 3 9cm = 3	4.5	9.5	13.5	20.5	24.5	29	35.5	40	46	51	55.5	60.5	65.5	70.5	75.5	80.5	85.5	90.5	95.5	100.5	105.5	110.5
WET UNIT WEIGHT g/cm ³	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SPECIFIC GRAVITY OF SOLIDS	-	2.756	2.766	2.779	2.759	2.765	2.758	2.770	2.758	2.759	2.765	2.768	2.757	2.757	2.755	2.751	2.741	2.759	2.756	2.752	2.758	2.755
WATER CONTENT, % DRY WEIGHT	-	87.01	88.68	87.89	89.83	80.95	86.20	91.00	89.67	86.68	86.71	88.23	88.35	89.67	86.56	88.92	87.61	87.16	87.98	86.60	87.23	
VOID RATIO DETERMINED IN LAB.	-	2.411	2.416	2.406	2.476	2.394	2.476	2.495	2.472	2.384	2.481	2.436	2.448	2.446	2.446	2.384	2.373	-	-	2.406	-	-
VOID RATIO AT 100% SATURATION	-	2.359	2.153	2.442	2.450	2.509	2.471	2.510	2.473	2.483	2.431	2.436	2.462	2.375	2.464	2.364	2.440	2.427	2.386	2.422	2.366	2.422
SATURATION, % ^b	-	86.5	100+	99.0	100+	100+	100+	100+	99.3	100+	99.3	100+	99.3	100+	99.3	100+	99.3	100+	99.6	100+	99.2	100
Liquid Limit	-	-	103	89	77	94	105	106	104	109	106	104	106	104	106	104	106	104	103	-	106	-
Plastic Limit	-	-	27	30	29	29	30	29	28	32	32	28	32	29	28	32	32	29	-	26	-	-
Liquidity Index, %	-	-	80	102	126	95	79	81	81	75	79	76	76	80	-	33	-	77	-	76	-	-
PLASTICITY INDEX	-	-	76	59	50	65	76	78	75	81	74	78	78	78	-	69	-	74	-	80	-	-
COMPRESSION INDEX FROM LL	-	-	0.65	0.56	0.49	0.59	0.66	0.67	0.65	0.69	0.66	0.67	0.66	0.67	-	0.62	-	0.65	-	0.67	-	-
SLUMP, % ^c	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.75	-	0.65	-	0.62	0.59	-
COMPRESSIVE "UNDISTURBED" PSI REMOVED, PSI	-	2.2	2.8	3.0	2.6	2.6	2.5	2.4	2.4	2.6	2.6	2.5	2.4	2.4	2.5	2.4	2.5	-	2.8	-	2.3	-
RELOADING SENSITIVITY	-	1.0	-	-	-	-	0.9	-	-	-	-	-	-	-	-	1.1	-	-	-	-	-	-
COHESION, PSI 9cm = 2	-	2.2	-	-	-	-	-	2.8	-	-	-	-	-	-	-	2.2	-	-	-	-	-	-
ACTIVITY	-	1.1	1.4	1.5	1.3	1.3	1.3	1.2	1.2	1.3	1.3	1.3	1.2	1.2	1.3	1.3	1.2	-	1.3	-	1.4	-
MODULUS OF ELASTICITY, PSI	-	77.3	68.4	105.5	91.4	91.4	91.4	91.4	91.4	84.4	84.4	91.4	91.4	91.4	91.4	91.4	91.4	-	91.4	-	98.4	-
GRAIN MEDIAN DIA. microns	-	37.4	58.1	58.4	67.2	66.3	49.2	48.1	47.5	45.7	46.2	46.3	49.1	42.5	-	40.2	-	39.1	-	44.4	-	-
SAND % > 2.006 < 3mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-
SILT % > 2.006 < 0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
CLAY % < 0.06	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	78	-	-	-	-	-	-
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-
Clayey	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SILLS

AREA & CORE

1959 - SONIC DEPTH, UNCORRECTED:1100 fms. CORE:100 ft. Gravity Rallenberg

APPROX. CORE PENETRATION: 72 in. CORE: 56 in. LONG. DIA.: 1.975 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40	40-42	42-44	44-46	46-48	48-50	50-52	52-54	
WET UNIT WEIGHT lb/ft ³	15.9±3	16.2±5	16.7±6	16.9±7	17.1±7	17.2±7	17.3±7	17.4±7	17.5±7	17.6±7	17.7±7	17.8±7	17.9±7	18.0±7	18.1±7	18.2±7	18.3±7	18.4±7	18.5±7	18.6±7	18.7±7	18.8±7	18.9±7	19.0±7	19.1±7	19.2±7	19.3±7	
SPECIFIC GRAVITY OF SOLIDS	1.41	1.48	1.72	1.74	1.78	1.80	1.82	1.82	1.87	1.90	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	
WATER CONTENT, % DRY WEIGHT	15.9±1	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	15.9±2	
VOID RATIO DETERMINED IN LAB.	1.65±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	1.66±1	
AT 100% SATURATION	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	1.20±1	
POROSITY, % _w	76.5	72.9	59.1	56.4	55.5	55.0	58.5	59.0	59.7	59.0	60.6	60.1	61.1	59.7	59.9	59.7	59.9	59.7	59.9	59.7	59.9	59.7	59.9	59.7	59.9	59.7	59.9	59.7
SATURATION, % _w	100*	100*	99.6	100*	99.6	100*	98.5	98.5	98.5	98.5	99.1	99.8	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*
Liquid Limit	52	44	21	21	21	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3	15.3
Plasticity Index, % _w	38.6	39.6	30.3	38	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37	37
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION WORK FROM LL FROM 4109 P.	0.33	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUMP %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE STRENGTH, UNDRAINED, PSI	-	0.06	-	1.67	-	3.71	-	1.05	-	1.17	-	1.07	-	1.08	-	1.08	-	1.3	-	1.22	-	1.00	-	1.04	-	1.04	-	1.22
STRENGTH, DRAINED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RELOADING SENSITIVITY, PSI	-	0.43	-	0.48	-	0.86	-	0.53	-	0.59	-	0.54	-	0.54	-	0.54	-	0.60	-	0.65	-	0.61	-	0.50	-	0.50	-	0.61
COMBINATION, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTIVITY, %	-	30.2	-	59.1	-	60.1	-	37.1	-	91.5	-	39.0	-	38.0	-	38.0	-	55.7	-	42.9	-	35.2	-	36.6	-	42.9	-	
HODULUS OF ELASTICITY, % _w	-	0.75	-	7.8	-	23.0	-	20.5	-	10.7	-	9.7	-	10.6	-	10.2	-	17.3	-	14.4	-	13.2	-	7.9	-	12.3	-	10.3
GRANU MEDIAN DIA., mm	-	4.5	-	7.8	-	14	-	14	-	4.8	-	7.7	-	7.7	-	7.7	-	4.8	-	4.8	-	4.8	-	4.8	-	4.8	-	4.8
SAND, %>60<100 mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SILT, %>2<60 mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLAY, %>2<60<2 mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUSPENIMENT, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLOSURE SHUT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yield "undisturbed", psi-2	0.11	-	0.51	-	0.68	-	0.62	-	0.60	-	0.60	-	0.60	-	0.60	-	0.64	-	0.53	-	0.60	-	0.64	-	0.64	-	0.64	
"undisturbed", psi-1	22.0	-	37.2	-	47.0	-	42.5	-	39.0	-	28.0	-	26.0	-	26.0	-	30.5	-	37.2	-	28.0	-	30.5	-	30.5	-	30.5	
Strength, undisturbed, psi-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Yield sensitivity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AREA E CORE 47

1959 - SONIC DEPTH, UNCORRECTED: 1100 fms. CORE: 260 in.

APPROX. CORE PENETRATION: 72 in. CORE: 62 in. LONG. DIAIN: 1.875 in.

GRAVITY KULLENBERG

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	12-14	14-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40	40-42	42-44	44-46	46-48	48-50	50-52	52-54	54-56	56-58	58-60		
WET UNIT WEIGHT lb/in ³	97.1	96.2	91.7	93.1	94.6	95.6	97.7	-	110.0	105.4	108.1	105.2	108.0	105.3	105.9	105.9	105.4	105.4	105.4	105.4	105.4	105.4	105.4	105.4	105.4	105.4	105.4	105.4		
SPECIFIC GRAVITY OF SOLIDS	2.725	2.720	2.725	2.729	2.732	2.735	2.747	-	3.76	3.69	3.78	3.73	3.69	3.70	3.71	3.68	3.71	3.69	3.70	3.71	3.72	3.73	3.74	3.75	3.76	3.77	3.78	3.79		
WATER CONTENT, % BY WEIGHT	31.46	100.11	36.97	35.35	38.89	36.50	71.23	-	49.42	51.38	55.99	51.00	52.25	51.19	53.94	52.22	52.22	52.22	52.22	52.22	52.22	52.22	52.22	52.22	52.22	52.22	52.22	52.22		
WATER RATIO DETERMINED IN L.B.	3.38	3.767	3.332	3.567	2.570	2.290	1.995	-	1.288	1.357	1.521	1.419	1.493	1.501	1.471	1.592	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799		
AT 100% SATURATION	3.093	2.722	2.644	2.598	2.317	2.227	1.929	-	1.582	1.582	1.524	1.416	1.469	1.465	1.484	1.605	1.620	1.603	1.581	1.581	1.581	1.581	1.581	1.581	1.581	1.581	1.581	1.581		
POROSITY, %	75.8	72.2	72.6	72.0	69.9	69.1	66.6	-	57.0	61.0	60.3	60.7	58.7	59.9	60.0	61.5	61.0	61.3	59.5	61.4	61.5	61.0	61.3	59.5	61.1	60.2	58.7	57.6		
SATURATION, %	96.5	94.4	100.0*	100.0*	99.9	99.4	97.7	-	100*	98.8	98.2	98.9	100**	99.9	100**	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	100*	
LIQUID LIMIT	160	150	152	127	120	96	-	142	182	174	151	152	152	152	174	181	167	166	166	166	166	166	166	166	166	166	166	166	166	
PLASTIC LIMIT	194	163	156	152	127	120	96	-	142	182	174	151	152	152	152	174	181	167	166	166	166	166	166	166	166	166	166	166	166	
PLASTICITY INDEX	43	43	43	43	43	43	43	-	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
COMPRESSION INDEX FROM LL FRM 6 to 9 P.S.	0.46	-	-	-	-	-	-	-	0.28	-	-	-	-	-	0.27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUMPFS %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE UNDRAINED, PSI	-	1.53	-	1.49	-	1.52	2.93	-	1.13	-	1.32	-	1.55	-	1.19	-	1.22	-	1.44	-	1.27	-	-	-	-	-	-	-	-	-
STRENGTH RELOADING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, PSI	-	0.77	-	0.75	-	0.76	1.147	-	0.57	-	0.66	-	0.78	-	0.89	-	0.63	-	0.73	-	0.64	-	-	-	-	-	-	-	-	-
COHESION, g/cm ²	-	54.1	-	52.7	-	53.4	103.4	-	40.1	-	46.4	-	48.8	-	62.6	-	49.9	-	51.3	-	52.4	-	-	-	-	-	-	-	-	-
ACTIVITY	-	24.2	-	11.4	-	25.2	50.7	-	12.7	-	24.2	-	21.5	-	26.2	-	24.9	-	28.7	-	31.4	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	9.1	-	1.8	-	1.8	13.8	-	0.4	-	8.4	-	3.0	-	8.4	-	3.0	-	47	-	2.8	-	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA, microns	-	10	-	100	-	0	0	-	100	-	0	-	48	-	47	-	9	-	46	-	45	-	-	-	-	-	-	-	-	-
SAND, % to 60 < 2 mm	-	36	-	32	-	32	Silt, % to 2.0 < 0.024	-	0	-	0	-	0	-	0	-	0	-	0	-	0	-	-	-	-	-	-	-	-	-
CLAY, % to 2.0 < 0.024	-	-	-	-	-	-	Silt, % to 0.024	-	Sand	-	Cheval salt																			
VACUUM	"well disturbed," psi	0.31	-	0.76	-	1.39	-	-	-	0.61	-	0.75	-	0.76	-	0.69	-	0.58	-	0.66	-	0.57	-	0.76	-	0.76	-	0.76	-	0.76
SHEAR STRENGTH, psi	"well disturbed," psi	3.12	-	53.4	-	97.6	-	-	-	42.3	-	53.4	-	56.2	-	40.2	-	46.3	-	49.1	-	53.4	-	68.2	-	68.2	-	68.2	-	68.2
VACUUM SENSITIVITY	"well disturbed," psi	-	-	-	-	3.9	-	-	-	-	-	0.15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AREA E CORE

48

CRUISE: 1959 SONIC DEPTH UNCORRECTED 1200 mms. CORE: 260-16 Gravity Kullenberg
 APPROX. CORER PENETRATION: 72 IN. CORE: 43 in. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DISTANCE FROM TOP OF CORE, in	0-2	2-4	4-6	6-8	8-10	10-12	11-13	14-16	16-18	18-20	20-22	22-24	24-26	26-28	28-30	30-32	32-34	34-36	36-38	38-40
WET UNIT WEIGHT, lb ft ⁻³	85.9	90.1	92.2	95.7	96.3	-	-	106.7	103.3	105.0	100.5	101.0	100.8	100.9	102.1	100.5	101.1	101.9	99.7	100.6
SPECIFIC GRAVITY OF SOLIDS	1.38	1.44	1.48	1.53	1.54	-	-	1.71	1.66	1.68	1.64	1.62	1.61	1.62	1.60	1.64	1.63	1.63	1.60	1.61
WATER CONTENT, % OF WEIGHT	2.72%	2.73%	2.77%	2.79%	2.79%	-	-	2.74%	2.74%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%	2.75%
VOID RATIO DETERMINED IN LAB.	128.31	105.69	95.66	81.93	76.74	-	-	39.95	57.94	56.24	66.36	66.31	66.75	68.46	61.87	59.15	65.38	65.93	70.33	67.73
AT 100% SATURATION	3.525	2.976	2.654	2.232	2.137	-	-	3.08	1.6%	1.52%	1.382	1.84%	1.84%	1.84%	1.85%	1.85%	1.85%	1.85%	1.85%	1.85%
POROSITY, %	77.9	74.7	72.4	68.8	68.1	-	-	37.6	4.8%	2.210	2.102	-	-	-	-	-	-	-	-	-
SATURATION, %	99.4	100%	99.8	99.7	98.4	-	-	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4	97.4
Liquid Limit	75	27	113	104	-	-	-	52	52	52	52	52	52	52	52	52	52	52	52	52
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLASTICITY INDEX, %	212	171	143	113	104	-	-	84	115	104	137	136	138	137	136	137	139	139	139	135
COMPRESSION INDEX, FROM WIL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE STRAIN FROM E LOG P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED" PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STRENGTH REMOVED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CONSTITUTIVE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA., MICRONS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SAND, % > 60μ < 2 mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SILT, % > 2 μ < 60μ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLAY, % < 2 μ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vane Shear "undisturbed," psi	0.19	-	0.43	-	1.94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
"undisturbed," psi	1.31	-	3.10	-	136.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Strength	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

AREA 7 CORE 6

CRUISE: 1259 SONIC DEPTM. UNCORRECTED: 1200 fms. COREL: 225 ft. Gravity Hydroplastic
APPROX. CORE PENETRATION: 112 IN. CORE: 106 IN. LONG: DIA. 3.22 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	
DISTANCE FROM TOP OF CORE, ft.	0.5	4.5	9	13.5	17.5	19.5	21.5	24.5	28.5	30.5	32.5	35	37.5	40.5	43.5	46.5	49	51	52.5	54.5	56.5	58.5	60.5	62.5	64.5	67		
NET UNIT WEIGHT, g/cm ³	1.62±0.1	2.01±0.1	1.14±0.1	1.15±0.2	1.16±0.2	1.16±0.5	1.17±0.3	1.17±0.4	1.19±0.4	1.20±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1	1.17±1.1		
SPECIFIC GRAVITY OF SOLIDS	2.774	1.771	1.771	1.783	1.783	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786		
WATER CONTENT % DRY WEIGHT	18.74	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745		
VOID RATIO DETERMINED IN LAB.	1.335	2.272	1.151	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334	1.334		
VOID RATIO AT 100 % SATURATION	1.334	1.289	1.341	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165	1.165		
POROSITY, %	57.2	56.0	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2	58.2		
SATURATION, %	99.2	100.0*	100.0	99.5	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Liquid Limit	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	
Plastic Limit	19	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	
Liquidity Index, %	.355	.173	.195	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	.170	
PLASTICITY INDEX	16	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	15	
COMPRESSION INDEX FROM LR	0.22	0.22	0.19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
FROM ELLIPSE P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SLEUTH %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE STRENGTH, psi	0.933	1.633	1.55	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REDUCED PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REDUCING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, psi	0.42	0.54	0.47	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ACTIVITY	0.5	0.4	0.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MODULUS OF ELASTICITY, psi	9.4	20.5	29.3	3	38.6	20.1	25.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAN MEDIUM DIA.	6.1	7.1	7.1	7.1	7.1	7.1	6.1	6.1	6.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	7.1	
MICROSONS	14.2	23	23	25	28	25	21	18	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14	14
SAND, % > 600 < 1 mm	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31	31
SILT, % > 2 & < 600	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39	39
SILT, % < 24	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30
SEDIMENT TYPE	Clay	Clay	Clay																									

(Results)

(Probable)

BE A PRACTICAL PERSON

1959. SONIC DEPTH, UNCORRECTED, 1240 fms. CORER, 400 lb. Gravity Kullenberg

AREA F CORE 11

CRUISE: 1959 SONIC DEPTH, UNCORRECTED: 1340 fms. COREL: 275 lb. Gravity Hydroplastic

APPROX. CORER PENETRATION DATA: CORE: 60 in. LONG. DIA. & 3.22 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
DISTANCE FROM TOP OF CORE, in	0-4	4-8	8-12	12-13	15-19	19-23	23-27	27-28	28-32	32-36	36-40	40-41	44-48	48-52	52-56	56-57
WET UNIT WEIGHT 9cm -3	88.8	90.6	91.4	92.2	94.2	96.7	97.5	97.9	98.9	95.1	94.8	94.6	94.6	91.5	91.1	91.6
SPECIFIC GRAVITY OF SOLIDS	1.452	1.45	1.45	1.48	1.51	1.55	1.54	1.57	1.52	1.52	1.52	1.52	1.47	1.47	1.46	1.47
WATER CONTENT, % DRY WEIGHT	2.053	2.745	2.745	2.740	2.755	2.74	2.756	2.742	2.761	2.773	2.764	2.771	2.783	2.780	2.761	2.761
DETERMINED IN LAB.	111.24	102.63	98.6	95.9	85.4	86.6	86.6	87.9	83.9	86.6	85.6	85.6	85.72	97.0	101.3	102.16
VOID RATIO AT 100% SATURATION	3.073	2.830	2.731	-	-	2.263	2.262	-	2.305	2.362	2.395	-	2.601	2.821	2.858	-
POROSITY, %	75.4	73.9	73.3	72.4	70.4	68.4	67.3	67.0	70.5	70.3	70.5	70.4	72.2	73.8	74.1	73.3
SATURATION, %	99.3	99.6	99.1	99.8	98.8	99.6	99.6	99.6	99.3	99.3	99.6	99.6	99.9	99.9	99.8	99.7
LIQUID LIMIT	83	76	-	-	72	-	66	-	-	72	-	-	76	-	75	-
PLASTIC LIMIT	34	33	-	-	31	-	30	-	-	29	-	-	31	-	33	-
LIQUIDITY INDEX, %	-	-	-	-	13.3	-	12.1	-	-	13.2	-	-	14.7	-	16.6	-
PLASTICITY INDEX	49	43	-	-	40	-	33	-	-	43	-	-	45	-	42	-
COMPRESSION INDEX FROM LL	0.52	0.48	-	-	0.45	-	0.45	-	-	0.45	-	-	0.48	-	0.47	-
SLUMP, %	-	-	-	-	56.95	-	-	-	0.71	-	-	0.79	-	-	-	0.83
COMPRESSIVE "UNDISTURBED" PSI STRENGTH REMOVED, PSI	0.82	1.42	1.26	-	-	1.75	1.99	2.01	-	1.37	1.75	1.79	-	1.81	1.53	1.23
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION 9cm -2	0.15	0.70	0.63	-	0.83	0.92	1.01	-	0.69	0.83	0.89	-	0.91	0.77	0.62	-
ACTIVITY	28.8	49.9	44.3	-	61.9	69.6	73.1	-	42.5	61.9	62.6	-	64.0	54.1	43.6	-
MODULUS OF ELASTICITY, PSI	1.0	0.9	-	-	0.9	-	0.6	-	-	0.8	-	0.8	-	1.8	-	-
GRAIN MEDIAN DIA. MICRONS	9.5	21.9	53.4	-	39.4	31.8	40.5	-	20.1	36.1	33.6	-	62.6	28.9	26.0	-
SAND, % > 40µ (< 2mm)	3	3	4	4	5	6	4	-	3	3	3	-	3	2	2	-
SILT, % (> 2µ < 60µ)	42	50	51	50	50	52	-	46	42	-	-	-	42	43	43	-
CLAY, % (< 2µ)	13	47	45	45	42	44	-	46	51	55	-	-	55	55	55	-
SEDIMENT TYPE													SILTY CLAY			

BEA 2 COE 12

1959 - SONIC DEPTH - UNCORRECTED: 1330 fms. 000000: 350 [infrared by Kullenberg]

AREA & CORE 13

CRUISE: 1959. SONIC DEPTH, UNCORRECTED: 1320 m.s. COREID: 300 lb. Gravity Kullenberg

APPROX. CORE PENETRATION: 56 in. LONG, DIAM.: 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
DISTANCE FROM TOP OF CORE, in	0.5	2.5	4.5	6.5	8.5	10.5	12.5	14.5	16.5	18.5	20.5	22.5	24.5	26.5	28.5	30.5	32.5	34.5	36.5	38.5	40.5	42.5	44.5	46.5	
WET UNIT WEIGHT, lb/ft ³	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	6.1	
SPECIFIC GRAVITY OF SOLIDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
WATER CONTENT % DRY WEIGHT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VOID RATIO DETERMINED IN LAB.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VOID RATIO AT 100% SATURATION	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SATURATION, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LIQUID LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSION INDEX FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE "UNDISTURBED" PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
STRENGTH REMOLED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, 9 cm ⁻²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAIN MEDIAN DIA.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MICROSTRUCTURES	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SAND, % > 60μ < 2 mm	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SILT, % > 2 μ < 0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLAY, % < 2 μ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CAYER, Silt	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SILTY CLAY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

LIBERA = CORRE

CRUISE: 1959 SONIC DEPTH, UNCORRECTED: 1310 fms. CORRECTION: 250 lb. Gravity Kullenberg

APPROX. CORE PENETRATION: 33+ IN. LONG. DIA.: 1.075 in.		IN. CORE: 68 in. LONG. DIA.: 1.075 in.	
SAMPLE NUMBER	TEST NUMBER	TEST NUMBER	TEST NUMBER
1	1	2	3
2	3	4	5
3	5	6	7
4	7	9	10
5	11	12	13
6	13	14	15
7	16	17	18
8	19	20	21
9	22	23	24
10	25	26	27
11	28	29	30
12	31	32	33
13	34	35	36
14	37	38	39
15	40	41	42
16	43	44	45
17	46	47	48
18	49	50	51
19	52	53	54
20	55	56	57
21	58	59	60
22	61	62	63
23	64	65	66
24	67	68	69
25	70	71	72
26	73	74	75
27	76	77	78
28	79	80	81
29	82	83	84
30	85	86	87
31	88	89	90
32	91	92	93
33	94	95	96
34	97	98	99
35	100	101	102
36	103	104	105
37	106	107	108
38	109	110	111
39	112	113	114
40	115	116	117
41	118	119	120
42	121	122	123
43	124	125	126
44	127	128	129
45	130	131	132
46	133	134	135
47	136	137	138
48	139	140	141
49	142	143	144
50	145	146	147
51	148	149	150
52	151	152	153
53	154	155	156
54	157	158	159
55	160	161	162
56	163	164	165
57	166	167	168
58	169	170	171
59	172	173	174
60	175	176	177
61	178	179	180
62	181	182	183
63	184	185	186
64	187	188	189
65	190	191	192
66	193	194	195
67	196	197	198
68	199	200	201
69	202	203	204
70	205	206	207
71	208	209	210
72	211	212	213
73	214	215	216
74	217	218	219
75	220	221	222
76	223	224	225
77	226	227	228
78	229	230	231
79	232	233	234
80	235	236	237
81	238	239	240
82	241	242	243
83	244	245	246
84	247	248	249
85	250	251	252
86	253	254	255
87	256	257	258
88	259	260	261
89	262	263	264
90	265	266	267
91	268	269	270
92	271	272	273
93	274	275	276
94	277	278	279
95	280	281	282
96	283	284	285
97	286	287	288
98	289	290	291
99	292	293	294
100	295	296	297
101	298	299	300
102	301	302	303
103	304	305	306
104	307	308	309
105	310	311	312
106	313	314	315
107	316	317	318
108	319	320	321
109	322	323	324
110	325	326	327
111	328	329	330
112	331	332	333
113	334	335	336
114	337	338	339
115	340	341	342
116	343	344	345
117	346	347	348
118	349	350	351
119	352	353	354
120	355	356	357
121	358	359	360
122	361	362	363
123	364	365	366
124	367	368	369
125	370	371	372
126	373	374	375
127	376	377	378
128	379	380	381
129	382	383	384
130	385	386	387
131	388	389	390
132	391	392	393
133	394	395	396
134	397	398	399
135	400	401	402
136	403	404	405
137	406	407	408
138	409	410	411
139	412	413	414
140	415	416	417
141	418	419	420
142	421	422	423
143	424	425	426
144	427	428	429
145	430	431	432
146	433	434	435
147	436	437	438
148	439	440	441
149	442	443	444
150	445	446	447
151	448	449	450
152	451	452	453
153	454	455	456
154	457	458	459
155	460	461	462
156	463	464	465
157	466	467	468
158	469	470	471
159	472	473	474
160	475	476	477
161	478	479	480
162	481	482	483
163	484	485	486
164	487	488	489
165	490	491	492
166	493	494	495
167	496	497	498
168	499	500	501
169	502	503	504
170	505	506	507
171	508	509	510
172	511	512	513
173	514	515	516
174	517	518	519
175	520	521	522
176	523	524	525
177	526	527	528
178	529	530	531
179	532	533	534
180	535	536	537
181	538	539	540
182	541	542	543
183	544	545	546
184	547	548	549
185	550	551	552
186	553	554	555
187	556	557	558
188	559	560	561
189	562	563	564
190	565	566	567
191	568	569	570
192	571	572	573
193	574	575	576
194	577	578	579
195	580	581	582
196	583	584	585
197	586	587	588
198	589	590	591
199	592	593	594
200	595	596	597
201	598	599	600
202	601	602	603
203	604	605	606
204	607	608	609
205	610	611	612
206	613	614	615
207	616	617	618
208	619	620	621
209	622	623	624
210	625	626	627
211	628	629	630
212	631	632	633
213	634	635	636
214	637	638	639
215	640	641	642
216	643	644	645
217	646	647	648
218	649	650	651
219	652	653	654
220	655	656	657
221	658	659	660
222	661	662	663
223	664	665	666
224	667	668	669
225	670	671	672
226	673	674	675
227	676	677	678
228	679	680	681
229	682	683	684
230	685	686	687
231	688	689	690
232	691	692	693
233	694	695	696
234	697	698	699
235	700	701	702
236	703	704	705
237	706	707	708
238	709	710	711
239	712	713	714
240	715	716	717
241	718	719	720
242	721	722	723
243	724	725	726
244	727	728	729
245	730	731	732
246	733	734	735
247	736	737	738
248	739	740	741
249	742	743	744
250	745	746	747
251	748	749	750
252	751	752	753
253	754	755	756
254	757	758	759
255	760	761	762
256	763	764	765
257	766	767	768
258	769	770	771
259	772	773	774
260	775	776	777
261	778	779	780
262	781	782	783
263	784	785	786
264	787	788	789
265	790	791	792
266	793	794	795
267	796	797	798
268	799	800	801
269	802	803	804
270	805	806	807
271	808	809	810
272	811	812	813
273	814	815	816
274	817	818	819
275	820	821	822
276	823	824	825
277	826	827	828
278	829	830	831
279	832	833	834
280	835	836	837
281	838	839	840
282	841	842	843
283	844	845	846
284	847	848	849
285	850	851	852
286	853	854	855
287	856	857	858
288	859	860	861
289	862	863	864
290	865	866	867
291	868	869	870
292	871	872	873
293	874	875	876
294	877	878	879
295	880	881	882
296	883	884	885
297	886	887	888
298	889	890	891
299	892	893	894
300	895	896	897
301	898	899	900
302	901	902	903
303	904	905	906
304	907	908	909
305	910	911	912
306	913	914	915
307	916	917	918
308	919	920	921
309	922	923	924
310	925	926	927
311	928	929	930
312	931	932	933
313	934	935	936
314	937	938	939
315	940	941	942
316	943	944	945
317	946	947	948
318	949	950	951
319	952	953	954
320	955	956	957
321	958	959	960
322	961	962	963
323	964	965	966
324	967	968	969
325	970	971	972
326	973	974	975
327	976	977	978
328	979	980	981
329	982	983	984
330	985	986	987
331	988	989	990
332	991	992	993
333	994	995	996
334	997	998	999
335	999	999	999
336	999	999	999
337	999	999	999
338	999	99	

AREA & CORE 15

1959 SONIC DEPTH, UNCORRECTED: 1320 fms. CORE: 200 lb. Gravity Kullenberg

APPROX. CORE PENETRATION: 45 IN. CORE: 6 IN. LONG. DIA.: 1.075 IN.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	
DISTANCE FROM TOP OF CORE, ft.																													
0-2.2	2.2-4.7	4.7-7.9	7.9-11.2	11.2-13.5	13.5-16.2	16.2-21.2	21.2-23.7	23.7-26.7	26.7-29.2	29.2-31.5	31.5-33.7	33.7-35.2	35.2-37.5	37.5-39.7	39.7-41.2	41.2-43.5	43.5-45.7	45.7-48.7	48.7-51.2	51.2-53.5	53.5-55.7	55.7-57.7	57.7-59.2						
25.2	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3	25.3			
NET UNIT WEIGHT, lb/ft ³	2.30-2.35	2.35-2.39	2.39-2.43	2.43-2.47	2.47-2.51	2.51-2.55	2.55-2.59	2.59-2.63	2.63-2.67	2.67-2.71	2.71-2.75	2.75-2.79	2.79-2.83	2.83-2.87	2.87-2.91	2.91-2.95	2.95-2.99	2.99-3.03	3.03-3.07	3.07-3.11	3.11-3.15	3.15-3.19	3.19-3.23	3.23-3.27	3.27-3.31	3.31-3.35	3.35-3.39	3.39-3.43	
SPECIFIC GRAVITY OF SOLIDS	2.73-2.78	2.78-2.83	2.83-2.87	2.87-2.92	2.92-2.97	2.97-3.02	3.02-3.07	3.07-3.12	3.12-3.17	3.17-3.22	3.22-3.27	3.27-3.32	3.32-3.37	3.37-3.42	3.42-3.47	3.47-3.52	3.52-3.57	3.57-3.62	3.62-3.67	3.67-3.72	3.72-3.77	3.77-3.82	3.82-3.87	3.87-3.92	3.92-3.97	3.97-4.02	4.02-4.07	4.07-4.12	
WATER CONTENT, % DRY WEIGHT	12.0-12.5	12.5-13.0	13.0-13.5	13.5-14.0	14.0-14.5	14.5-15.0	15.0-15.5	15.5-16.0	16.0-16.5	16.5-17.0	17.0-17.5	17.5-18.0	18.0-18.5	18.5-19.0	19.0-19.5	19.5-20.0	20.0-20.5	20.5-21.0	21.0-21.5	21.5-22.0	22.0-22.5	22.5-23.0	23.0-23.5	23.5-24.0	24.0-24.5	24.5-25.0	25.0-25.5	25.5-26.0	
VOID RATIO DETERMINED IN LAB.	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	
VOID RATIO AT 100% SATURATION	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	3.339	
POROSITY, %	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	77.3	
LIGUID LIMIT	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	69.3	
PLASTIC LIMIT	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85	85
LIQUIDITY INDEX %	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35	35
LIQUIDITY INDEX	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	172	
PLASTICITY INDEX	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47	47
COMPRESSION INDEX FROM LL	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE STRENGTH, psi	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	
STRENGTH REMOVED, psi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REMOVAL SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMBINATION, psi	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	
COMBINATION, 2 cm ²	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	21.1	
ACTIVITY	0.9	0.9	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
MODULUS OF ELASTICITY, psi	4.8	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5	3.4	6.5
GRAIN MEDIAN DIA., mm	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
SAND, %, > 200 < 2 mm	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4	3	4
SILT, %, > 2 < 0.02 mm	46	47	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50	46	50
CLAY, %, < 0.02	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
SEDIMENT TYPE	SILTY CLAY																												
SALINITY	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
SALT, %, > 2 < 20	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41	41
SALINITY	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57	57
SALINITY, SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	SILTY CLAY	

REAL CORE 16

1959. SONIC DEPTH. UNCORRECTED: 1320 fms. CORER: 150 lb. Gravity Kullenberg
ROCK. CORER PENETRATION: SOH. IN. CORE: 67 in. LONG. DIAM. 1.875 in.
RISE:

AREA G CORE 2

CRUISE: 1959 - SONIC DEPTH: UNCORRECTED: 250 fms. CORE: 1200 lb. Piston Ewing
 APPROX. CORE PENETRATION: 200 IN. CORE: 222 in. LONG; DIAM.
 2.5 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
DISTANCE FROM TOP OF CORE, in.	0.4	4.8	8-12	12-16	20-	23-4	27-4	31-4	35-4	39-4	13-4	16.5-	50.5-	54.5-	58.5-	62.5-	
WEIGHT, lb. ft. ³	-	77.2	77.3	78.9	80.9	82.5	79.5	85.8	85.9	86.2	85.7	86.9	89.2	88.7	87.8	86.8	
WEIGHT UNIT WEIGHT, gm/cm ³	1.26	1.24	1.26	1.30	1.32	1.27	1.37	1.38	1.38	1.37	1.39	1.43	1.42	1.44	1.40	1.39	
SPECIFIC GRAVITY OF SOLIDS	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31	
WATER CONTENT, % DRY WEIGHT	232.28	232.05	210.77	175.91	152.54	148.14	129.46	127.23	125.89	122.97	108.65	115.10	120.31	122.44	122.44	122.44	
VOID RATIO DETERMINED IN LAB.	-	-	-	4.822	4.401	4.714	-	-	-	-	3.922	3.101	(3.39)	(3.18)	(3.24)	(3.05)	
AT 100% SATURATION (6.33)	5.714	5.754	4.899	4.388	4.10	3.58	3.52	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.54	3.443	
POROSITY, %	(36.15)	(56.41)	85.1	92.8	81.5	(85.52)	(78.21)	(77.9)	(78.0)	(77.7)	(77.3)	(77.7)	(76.5)	(76.0)	(76.9)	(77.2)	(77.5)
SATURATION %	-	-	-	100	99.7	99.7	-	-	-	-	97.4	-	-	-	-	-	99.1
Liquid Limit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plastic Limit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Liquidity Index, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION INDEX, FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION INDEX, FROM $\log P$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED", PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STRENGTH REMOVED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REHOLDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, 9 cm ²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA. microns	9.4	9.3	9.5	9.3	9.4	9.3	9.4	9.4	9.3	9.3	9.5	9.6	9.8	9.7	9.7	10.0	
SAND, % > 200 < 2 mm	3	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	
SILT, % > 2 < 60 μ	38	39	37	38	40	38	40	40	39	39	35	34	33	31	30	30	
CLAY, % < 2 μ	59	59	60	59	57	60	58	58	58	58	62	63	65	66	67	67	
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Vane "undisturbed", psi	-	-	0.18	0.17	0.31	-	-	-	-	0.73	-	-	-	-	-	-	0.16
Shear "undisturbed", gm ²	-	-	12.4	11.8	21.9	-	-	-	-	51.5	-	-	-	-	-	-	33.4
Strength remolded	-	-	0.03	0.05	0.07	-	-	-	-	0.18	-	-	-	-	-	-	0.18
Vane sensitivity	-	-	6.1	3.2	4.5	-	-	-	-	4.2	-	-	-	-	-	-	4.1

AREA G CORE 3

CRUISE: 1959 . SONIC DEPTH, UNCORRECTED: 250 fms. CORER: 300 lb.
 APPROX. CORER PENETRATION: 156 IN. CORE: 60 in. LONG, DIAM. 3.18 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8
DISTANCE FROM TOP OF CORE, in	0-4	4-8	8-12	12-	14.7	14.7-	18.7-	22.9-
WET UNIT WEIGHT lb ft ⁻³ gcm ⁻³	76.9 1.23	78.0 1.25	78.1 1.25	78.6 1.26	79.1 1.27	80.0 1.28	82.4 1.32	85.2 1.36
SPECIFIC GRAVITY OF SOLIDS	2.705					(2.7)		
WATER CONTENT, % DRY WEIGHT	235.22	222.87	223.35	213.26	213.30	195.80	165.20	149.50
VOID RATIO DETERMINED IN LAB.	-	5.989	-	-	-	-	-	-
AT 100% SATURATION	5.363	(6.04)	(6.05)	(5.76)	(5.76)	(5.31)	(4.48)	(4.05)
POROSITY, %	(86.4)	85.7	(85.8)	(85.3)	(85.3)	(84.0)	(81.7)	(80.3)
SATURATION, %	-	100+	-	-	-	-	-	-
LIQUID LIMIT	-	-	-	-	-	-	-	-
PLASTIC LIMIT	-	-	-	-	-	-	-	-
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-
PLASTICITY INDEX	-	-	-	-	-	-	-	-
COMPRESSION INDEX FROM LL	-	-	-	-	-	-	-	-
FROM e-log P	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-
COMPRESSIVE STRENGTH "UNDISTURBED", PSI	-	-	-	-	-	-	-	-
REMOLDED, PSI	-	-	-	-	-	-	-	-
REMOLDING SENSITIVITY	-	-	-	-	-	-	-	-
COHESION psi gcm ⁻²	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA.	phi microns	9.4 1.5	9.1 1.8	9.2 1.7	9.3 1.6	9.5 1.4	9.4 1.5	9.3 1.6
SAND, % > 60μ< 2mm	2	1	1	1	1	1	2	2
SILT, % > 2μ< 60μ	39	47	40	38	40	40	40	41
CLAY, % < 2μ	59	52	59	61	59	59	58	57
SEDIMENT TYPE					Silty	Clay		
Vane Shear strength Vane Sensitivity	-	0.20	-	-	-	-	-	-
"undisturbed", psi	-	14.1	-	-	-	-	-	-
"undisturbed", gcm ⁻²	-	0.05	-	-	-	-	-	-
remolded, psi	-	3.9	-	-	-	-	-	-

AREA G CORE

4

CRUISE: 1959. SONIC DEPTH, UNCORRECTED: 250 fms. CORER: 300 lb. Platen Hydroplastic
 APPROX. CORER PENETRATION: 184 in. CORE: 90 in. LONG. DIAM.: 3.18 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
DISTANCE FROM TOP OF CORE, in.	0.4	4-3	8-12	12-16	16-20	20-7	22-7	26-7	30-7	34-7	38-7	42-7	45-5	49-5	53-5	57-5	61-5	65-5
WET UNIT WEIGHT lb ft^{-3}	78.5	78.5	79.7	81.6	82.0	82.2	82.9	83.5	83.9	85.2	84.8	85.9	86.7	87.0	87.5	87.5	87.5	87.5
SPECIFIC GRAVITY OF SOLIDS	-	-	1.26	1.28	1.31	1.31	1.32	1.33	1.34	1.36	1.36	1.38	1.39	1.40	1.42	1.43	1.46	1.46
WATER CONTENT, % DRY WEIGHT	226.30	217.88	196.16	185.10	165.20	159.30	154.70	155.20	153.13	153.02	146.38	134.32	121.13	123.90	111.91	104.9	-	-
VOID RATIO DETERMINED IN LAB.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.03
VOID RATIO AT 100% SATURATION	(6.20)	(6.20)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)	(6.41)
POROSITY, %	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)	(55.3)
SATURATION, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100+
Liquid Limit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION INDEX, FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION INDEX, FROM e-log P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED" PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STRENGTH, REMOVED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION, g cm^{-2}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA. MICRONS	9.4	9.0	9.5	9.4	9.3	9.4	9.3	9.3	9.3	9.3	9.5	9.5	9.5	9.5	9.5	9.5	9.5	9.5
SILT, % > 60 μ m	41	39	39	41	41	42	42	42	42	42	41	40	39	39	40	37	37	36
SILT, % > 2 μ m	53	59	59	59	59	59	59	59	59	59	59	59	59	59	59	60	60	61
CLAY, % < 2 μ m	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vane Shear, "undisturbed," psi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.53
Vane Shear, "undisturbed," g cm^{-2}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.3
Vane Strength, removed, psi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Vane sensitivity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5.9

AREA 6 CORE 5

CRUISE: 1959 . SONIC DEPTH, UNCORRECTED: 250 fms. CORER: 1200 lb.
PISTON SWING
APPROX. CORER PENETRATION: 516 IN. CORE: 474 IN. LONG, DIAM. 2.5 IN.

SAMPLE NUMBER	1	2	3	4	5	6	7	8
DISTANCE FROM TOP OF CORE, IN	0-4	4-8	8-9	9-13	13-17	17-21	21-24	24-28
WET UNIT WEIGHT lb ft^{-3} g cm^{-3}	92.5 1.48	96.9 1.55	-	95.7 1.53	95.8 1.53	97.1 1.56	98.3 1.57	97.2 1.56
SPECIFIC GRAVITY OF SOLIDS	-	-	-	-	-	-	-	-
WATER CONTENT, % DRY WEIGHT	73.08	81.12	-	82.52	80.44	79.65	76.50	76.12
VOID RATIO DETERMINED IN LAB. AT 100% SATURATION	-	-	-	-	-	-	-	-
POROSITY, %	-	-	-	-	-	-	-	-
SATURATION %	-	-	-	-	-	-	-	-
LIQUID LIMIT	-	-	-	-	-	-	-	-
PLASTIC LIMIT	-	-	-	-	-	-	-	-
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-
PLASTICITY INDEX	-	-	-	-	-	-	-	-
COMPRESSION INDEX FROM LL FROM 0-100 P	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED", PSI STRENGTH REMOLODED, PSI	-	-	-	-	-	-	-	-
REMOLODING SENSITIVITY	-	-	-	-	-	-	-	-
COHESION PBI g cm^{-2}	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA. MICRONS	9.5 1.5	9.5 1.4	-	9.7 1.2	9.4 1.5	9.5 1.4	9.3 1.6	9.3 1.6
SAND, % > 60 μ < 2 mm	2	4	-	2	1	1	2	1
SILT, % > 2 μ < 60 μ	43	40	-	40	40	40	41	43
CLAY, % < 2 μ	55	56	-	58	59	59	57	56
SEDIMENT TYPE					SILTY CLAY			

AREA G CORE 6

CRUISE: 1959. SONIC DEPTH, UNCORRECTED: 250 fms. CORER: 150 lb. Gravity Hydroplastic APPROX. CORER PENETRATION: 84 in. CORE: 60 in. LONG. DIAM. 3.18 in.

AREA G CORE 8

CRUISE: 1959 SONIC DEPTH: UNCORRECTED: 220 fms. CORER: 300 lb. Gravity Hydroplastic

APPROX. CORE PENETRATION: 120 IN. CORE: 96 in. LONG, DIA.M.: 3.16 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
DISTANCE FROM TOP OF CORE, in	0-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40	40-44	44-48	48-52	52-56	56-60	60-64	64-68
WET UNIT WEIGHT 9cm ⁻²	1b 4.3	79.6	80.5	86.4	81.1	81.1	81.2	81.9	83.1	83.6	85.4	84.8	84.6	84.6	84.9	85.5	
SPECIFIC GRAVITY OF SOLIDS	(2.68)	2.684	2.682	2.700	2.710	2.710	2.710	2.710	2.710	2.710	2.710	2.710	2.710	2.710	2.710	2.710	
WATER CONTENT % DRY WEIGHT	206.70	168.40	175.49	170.94	166.90	165.20	163.20	153.10	153.20	144.30	144.30	144.10	144.10	144.10	144.07	143.70	
VOID RATIO DETERMINED IN LAB.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VOID RATIO AT 100% SATURATIONS	(5.56)	(4.94)	(4.70)	(4.63)	(4.56)	(4.58)	(4.42)	(4.15)	(4.28)	(3.92)	(3.92)	(3.85)	(3.85)	(3.85)	(3.80)	(3.80)	
POROSITY, %	(54.7)	(31.1)	(31.1)	(32.6)	(32.2)	(32.0)	(31.5)	(30.6)	(30.5)	(29.3)	(29.3)	(28.6)	(28.6)	(28.6)	(28.4)	(28.4)	
SATURATION, %	-	-	99.5	99.8	99.2	-	-	-	-	100+	-	-	-	-	100+	-	
Liquid Limit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liquidity Index, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSION INDEX FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSION INDEX FROM LL + $\log P$	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE "UNDISTURBED" PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
STRENGTH REMODELED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REMODELING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION 9cm ⁻²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAIN MEDIAN DIA. phi	9.5	9.0	9.1	9.0	9.3	9.2	9.4	9.0	9.1	9.3	9.2	9.2	9.2	9.0	9.1	9.1	
GRAIN, % < 2 mm	1.4	-	2.0	1.8	2.0	1.6	1.7	1.5	2.0	1.8	1.6	1.7	1.7	1.9	1.8	1.8	
SILT, % > 2 μ < 60 μ	43	-	49	46	47	44	45	43	49	46	44	46	45	45	47	46	
CLAY, % < 2 μ	55	-	49	52	51	54	53	55	48	52	54	52	53	51	52	52	
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Name	"Undisturbed," psi	-	0.36	0.12	0.55	-	-	-	-	0.74	-	-	-	-	0.44	-	
	"Disturbed," psi	-	25.2	20.5	38.4	-	-	-	-	51.7	-	-	-	-	39.9	-	
Shear strength, remodeled, psi	-	0.66	0.69	0.10	-	-	-	-	0.13	-	-	-	-	-	0.12	-	
Yield Sensitivity	-	6.2	4.7	5.5	-	-	-	-	5.8	-	-	-	-	-	3.8	-	

AREA G CORE 9

CRUISE: 1959. SONIC DEPTH, UNCORRECTED: 250 fms. CORED: 300 lb. Gravity Hydroplastic

APPROX. CORER PENETRATION: 84 IN. CORE: 54 IN. LONG, DIAM. 3.18 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13
DISTANCE FROM TOP OF CORE, in	0-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40	40-44	44-48	48-52
WET UNIT WEIGHT, lb/ft ³	79.4	80.1	80.3	80.5	80.8	80.7	-	-	-	83.9	84.7	85.7	85.7
SPECIFIC GRAVITY OF SOLIDS	(6.6)	2.695	2.703	-	-	-	(4.71)	-	-	1.34	1.36	1.37	1.37
WATER CONTENT, % DRY WEIGHT	207.20	203.10	197.53	195.98	192.44	-	187.00	157.70	155.44	147.14	144.70	133.14	133.14
VOID RATIO DETERMINED IN LAB.	-	-	4.994	4.993	-	-	-	-	-	1.009	-	-	-
AT 100% SATURATION	(5.54)	(5.44)	5.035	5.027	(5.22)	-	(4.53)	(4.24)	(4.22)	4.013	(3.92)	(3.61)	(3.61)
POROSITY, %	-	-	83.3	83.3	(83.3)	-	(81.8)	(81.0)	(80.8)	80.1	(79.7)	(78.4)	(78.4)
SATURATION, %	(84.7)	(84.5)	-	-	100+	100+	-	-	-	-	100+	-	-
LIQUID LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-	-	-	-	-	-
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION INDEX FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-
FROM e=10g p	-	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED" PSI	-	-	-	-	-	-	-	-	-	-	-	-	-
STRENGTH REMOLDED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-
REMOLDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-
COHESION	-	-	-	-	-	-	-	-	-	-	-	-	-
PSI	-	-	-	-	-	-	-	-	-	-	-	-	-
9cm ²	-	-	-	-	-	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA, microns	9.0	9.0	9.1	9.3	9.2	-	9.1	9.0	9.0	9.1	9.0	9.1	9.4
GANO, % > 60µ < 2mm	1.2	2.0	1.8	1.0	1.7	-	1.8	1.9	2.0	1.8	2.0	1.5	1.5
SILT, % > 2µ < 0.063mm	2	1	4	2	2	-	2	2	0	2	2	1	1
CLAY, % < 2µ	47	50	46	43	45	-	45	48	49	46	47	45	45
SEDIMENT TYPE	Silty Clayey Clay	Silt	Silty Clay	Silt	Silt	-	-	-	-	-	-	-	-
Vane "undisturbed", psi	-	-	0.20	0.19	-	-	-	-	-	0.52	-	-	-
Shear "undisturbed", gcm ⁻²	-	-	14.3	13.1	-	-	-	-	-	36.3	-	-	-
strength remolded, psi	-	-	0.05	0.06	-	-	-	-	-	0.16	-	-	-
Vane sensitivity	-	-	3.9	2.9	-	-	-	-	-	2.3	-	-	-

AREA G CORE 10

CRUISE: 1959 - SONIC DEPTH, UNCORRECTED: 250 fms. COPIER: 300 lb. Gravity Hydroplastic

APPROX. CORE PENETRATION: 96 IN. CORE: 72 IN. LONG, DIAM. 3.18 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
DISTANCE FROM TOP OF CORE, in	0-4	4-8	8-12	12-16	16-20	20-24	24-28	28-32	32-36	36-40	40-44	44-46	46-52	52-56	56-60	60-64	
WET UNIT WEIGHT lb ft^{-3}	80.8	81.7	83.7	86.0	89.2	93.8	91.0	90.9	90.7	91.5	92.4	93.8	94.0	94.9	95.2	95.3	
SPECIFIC GRAVITY OF SOLIDS	2.73	2.734	2.739	2.752	-	(3.77)	-	-	-	27.80	(4.78)	-	27.84	(2.78)	-	-	
WATER CONTENT, % DRY WEIGHT	184.00	170.60	160.35	142.00	114.23	108.20	109.80	106.60	102.90	99.80	94.40	96.30	99.00	88.50	92.54	86.00	
DETERMINED IN LAB.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VOID RATIO AT 100% SATURATION	4.309	3.868	3.125	-	-	-	-	-	-	2.789	-	-	-	-	2.535	-	
POROSITY, %	(5.04)	(4.66)	4.384	3.889	3.144	(3.00)	(3.09)	(2.92)	(2.84)	2.774	(2.68)	(2.69)	(2.77)	(2.46)	2.576	(2.39)	-
SATURATION, %	(83.6)	(82.5)	81.2	79.2	75.8	(75.0)	(75.2)	(74.8)	(73.9)	73.6	(72.4)	(72.8)	(73.4)	(71.2)	71.6	(70.4)	-
Liquid Limit	-	-	100+	100+	100+	-	-	-	-	99.5	-	-	-	-	100+	-	
Plastic Limit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liquidity Index, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSION INDEX FROM LL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SLUMP %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE "UNDRAINED", PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
STRENGTH REMOVED, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, 9 cm^{-2}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAIN MEDIAN DIA., MICRONS	9.2	9.6	9.1	9.4	9.1	9.2	9.0	9.0	9.2	9.0	9.1	9.2	9.6	9.1	9.4	10.5	
SAND, % > 60 < 2 mm	1.7	1.3	1.3	1.5	1.3	1.7	2.0	0.9	0.6	1.6	1.9	1.8	1.7	1.3	1.8	-	
SILT, % > 2 < 60 μ	3	2	4	3	5	9	9	10	9	10	8	7	6	10	4	-	
CLAY, % < 2 μ	46	43	44	43	43	41	37	37	38	39	40	42	39	39	41	-	
SEDIMENT TYPE	51	55	52	54	52	52	50	54	53	53	52	51	55	51	55	-	
Wane "undisturbed", psi	-	-	0.24	0.29	0.42	-	-	-	-	0.46	-	-	-	-	0.52	-	
"undisturbed", cm^{-2}	-	-	17.1	20.7	29.2	-	-	-	-	34.1	-	-	-	-	36.2	-	
Strength remoulded, psi	-	-	0.04	0.06	0.10	-	-	-	-	0.33	-	-	-	-	0.12	-	
Wane sensitivity	-	-	6.1	5.1	4.4	-	-	-	-	3.7	-	-	-	-	4.1	-	

AREA G CORE 11

CRUISE: 1959. SONIC DEPTH, UNCORRECTED: 250 fms. CORER: 300 lb. Gravity Hydrosat

APPROX. CORER PENETRATION: 84 in. CORE: 48 in. LONG, DIA.: 3.18 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12
DISTANCE FROM TOP OF CORE, in	4-4	4-3	5-12	12-15	15-22	22-25	24-25	28-32	32-36	36-44	44-44	44-45
WET UNIT WEIGHT g/cm ⁻³	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6
SPECIFIC GRAVITY OF SOLIDS	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7
WATER CONTENT, % DRY WEIGHT	1.3	1.3	1.32	1.33	1.33	1.34	1.34	1.34	1.34	1.34	1.34	1.34
VOID RATIO DETERMINED IN LAB. AT 100% SATURATION	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
POROSITY, %	-	-	-	-	-	-	-	-	-	-	-	-
SATURATION %	-	-	-	-	-	-	-	-	-	-	-	-
LIQUID LIMIT	-	-	-	-	-	-	-	-	-	-	-	-
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-	-	-	-	-
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSION INDEX FROM LL FROM e-log P	-	-	-	-	-	-	-	-	-	-	-	-
SLUMP, %	-	-	-	-	-	-	-	-	-	-	-	-
COMPRESSIVE "UNDISTURBED", PSI STRENGTH REMOVED, PSI	-	-	-	-	-	-	-	-	-	-	-	-
REMOULDING SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-
COHESION g/cm ⁻²	-	-	-	-	-	-	-	-	-	-	-	-
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-
GRAIN MEDIAN DIA. microns	0.1	0.1	0.3	0.3	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
SAND, % > 60 < 2 mm	2	1	1	1	1	1	1	1	1	1	1	1
SILT, % > 2 < 60 μ	46	46	46	46	46	46	46	46	46	46	46	46
CLAY, % < 2 μ	52	52	52	52	52	52	52	52	52	52	52	52
SEDIMENT TYPE	3	3	3	3	3	3	3	3	3	3	3	3

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AREA B CURE

AREA E CORE 12

(Continued)

CRUISE: 1959 - SONIC DEPTH, UNCORRECTED: 2800 fms., CORRECTED: 1200 ft.

PISTON DIA. 2.5 in.

APPROX. COHERENT PENETRATION, D.G. IN. CORE: 203 in. LONG, DIAM.

2.5 in.

SAMPLE NUMBER	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68			
DISTANCE FROM TOP OF CORE, ft	72.5	75	76.5	77	78.5	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106			
WET UNIT WEIGHT, lb/in. ³	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12		
WEIGHT CONDUCTIVITY, ohm-m	1.556	1.565	1.566	1.567	1.568	1.569	1.57	1.571	1.572	1.573	1.574	1.575	1.576	1.577	1.578	1.579	1.58	1.581	1.582	1.583	1.584	1.585	1.586	1.587	1.588	1.589	1.59	1.591	1.592	1.593	1.594	1.595	1.596	1.597	1.598	1.599
WATER CONTENT, % BY WEIGHT	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5		
DETERGENT IN LAB. 100%	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	1.481	
VOID RATIO AT 100% SATURATION	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	3.931	
SATURATION, %	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7	77.7		
LIQUID LIMIT	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSION INDEX, FROM E-12 P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SUMP %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE STRENGTH, psi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ADSORBING CAPACITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CHEMOSIS, psi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MODULUS OF ELASTICITY, psi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAIN MEDIAN DIA.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LAND % > 200 microns	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SILT, % > 2.5 < 200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CLAY, % > 2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SEGMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Value	"Unadjusted," p. 2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Stress measured, GPa	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Stress measured, GPa	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	
Vane sensitivity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

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AREA A - CORE 13

1959 SONIC DEPTH, UNCORRECTED, 1800 fms., CORER: 7 in. Gentry Fullambers

APPROX. CORE PENETRATION, IN. IN. CORE: 56 in. LONG, DIAM. 1.875 in.

SAMPLE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
DISTANCE FROM TOP OF CORE, m	0-6.5	6.5-10.5	10.5-12	12-16	16-20	20-22	22	24.2	26.2	28.2	30.2	32.2	34.7	36.7	38.7	41	42.5	44.5	46.5	48.5	50.5	52.5	54.5	56.5	58.5		
WEIGHT, gm/m ³	1.11-3	1.11-1.4	-	1.40	1.40	1.40	1.40	1.43	1.43	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	1.42	
SPECIFIC GRAVITY OF SOLIDS	2.793	2.777	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760	2.760		
WATER CONTENT, % OF WEIGHT	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07	12.07		
VOID RATIO DETERMINED IN LAB	3.07	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06	3.06		
FORSTNER, % SATURATION	3.988	3.510	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280	3.280		
SATURATION, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Liquid limit	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTIC LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
LIQUIDITY INDEX, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PLASTICITY INDEX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CORRECTION INDEX FROM E-05 P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SUMM, %	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COMPRESSIVE "UNDISTURBED" PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
STRENGTH, REBRODDED PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
REBRODDED SENSITIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
COHESION, gm/cm ²	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
ACTIVITY	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MODULUS OF ELASTICITY, PSI	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
GRAN. MEDIAN DIA. phi	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
MICRONS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
SAND, % > 600 < mm	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
SILT, % > 2 < 600	31	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	36	
CLAY, % > 2	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	
SEDIMENT TYPE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
VANE	"Undisturbed," psi 2	-	1.02	-	1.03	-	2.52	-	2.53	-	2.53	-	2.53	-	2.53	-	2.53	-	2.53	-	2.53	-	2.53	-	2.53	-	2.53
Shear modulus, gcm ²	-	71.7	-	97.0	-	177.0	-	154.0	-	154.0	-	154.0	-	154.0	-	154.0	-	154.0	-	154.0	-	154.0	-	154.0	-	154.0	
Strength, vane sensitivity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Vane sensitivity	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

U. S. Navy Hydrographic Office
INVESTIGATIONS OF DEEP-SEA SEDIMENT
CORES, II. MASS PHYSICAL PROPERTIES,
October 1952, 144 p., including 17 figures, 35
plates, 9 tables. (H. O. Tr-100).

The second of three Hydrographic Office reports
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from water saturation, liquid and plastic limits, and
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1. Bottom Sediments - mass physical
properties

2. Mass physical properties - bottom
sediments

3. North Atlantic Ocean - bottom
sediments

4. Western Mediterranean Sea -
bottom sediments

5. Central Pacific - bottom sediments -
Ships: USS SAN PABLO

6. Ships: USS REBOROTH

7. Ships: USS RHEA

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ii. Author: Adrien F. Richards
iii. H. O. Tr-101

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Sediment Cores, II, Mass
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ii. Author: Adrien F. Richards
iii. H. O. Tr-102

1. Title: Investigations of Deep-Sea
Sediment Cores, II, Mass
Physical Properties.
ii. Author: Adrien F. Richards
iii. H. O. Tr-106

Appendix A contains a discussion of salinity
correction for specific gravity measurements.

Appendix B contains data tables for 25 ex-
periments.

U. S. Navy Hydrographic Office
U. S. NAVY HYDROGRAPHIC OFFICE INVESTIGATION OF DEEP-SEA SEDIMENT CORES, II, MASS PHYSICAL PROPERTIES, October 1962 - 45 P., including 17 figs., 35 tables, 9 tables. (H. O. TR-10).

The second of three Hydrographic Office reports describing results of investigation of mass physical properties of 35 sediment cores collected from hydrographic Office oceanographic ships in 1958 and 1959.

This report discusses results of laboratory measurements of the mass physical properties of more than 200 samples including grain size, specific gravity, porosity, water saturation, liquid and plastic limits, and compressive and/or shear strength. Also compared were porosity, liquidity index, plastic index, cohesion, sensitivity, liquidity index, plastic index, and Author: Adrian F. Richards

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7. Ships - USS REHOBOTH

1. Title: Investigation of Deep-Sea Sediment Cores, II, Mass Physical Properties.
Author: Adrian F. Richards
iii. H. O. TR-106

U. S. Navy Hydrographic Office
U. S. NAVY HYDROGRAPHIC OFFICE INVESTIGATION OF DEEP-SEA SEDIMENT CORES, III, MASS PHYSICAL PROPERTIES, October 1962 - 44 P., including 17 figs., 25 plates, 9 tables. (H. O. TR-106).

The second of three Hydrographic Office reports describing results of investigation of mass physical properties of 35 sediment cores collected from hydrographic Office oceanographic ships in 1958 and 1959.

This report discusses results of laboratory measurements of the mass physical properties of more than 200 samples including grain size, specific gravity, porosity, water saturation, liquid and plastic limits, and compressive and/or shear strength. Also compared were porosity, liquidity index, plastic index, cohesion, sensitivity, liquidity index, plastic index, and Author: Adrian F. Richards
iii. H. O. TR-106

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1. Title: Investigation of Deep-Sea Sediment Cores, II, Mass Physical Properties.
Author: Adrian F. Richards
iii. H. O. TR-106

Appendix A contains a discussion of salinity connection for specific gravity measurements.

Appendix B contains a discussion of salinity.

Richards, Adrian F.

AUTHOR

INVESTIGATIONS OF DEEP-SEA SEDI -
MENT CORES. II. MASS PHYSICAL

